

92c

C U R I O U S
R E M A R K S
A N D
O B S E R V A T I O N S

I N
P H Y S I C S, A N A T O M Y, C H I R U R G E R Y,
C H E M I S T R Y, B O T A N Y, and M E D I C I N E.

Extracted from the
H I S T O R Y A N D M E M O I R S
O F T H E
R o y a l A c a d e m y o f S c i e n c e s a t *Paris*.

C O N T A I N I N G
Such useful D I S C O V E R I E S as have not been col-
lected by other Writers on the same Subjects.

*Quæ contuens animus, accipit ab his cognitionem Deorum; ex
quâ oritur pietas: cui conjuncta justitia est, reliquæque vir-
tutes: è quibus vita beata existit.*

Cicero de Naturâ Deorum.

B Y
D r. P E T E R T E M P L E M A N.

L O N D O N :
Printed for C. DAVIS, in *Holborn*; and P. VAILLANT,
in the *Strand*.

M D C C L I I I.

16



3 *[Handwritten signature]*

TO
Doctor Benjamin Bosanquet,
F. R. S.

Dear Sir,

IT is not in the usual stile of dedications that I address this work to you ; I only beg leave to inscribe your name, as a friend, philosopher, and physician. In short, I am going to compliment myself rather than you by observing that I follow the example of Cicero in addressing his books of Academics to his friend Varro, who was justly stiled the most learned of all the Romans. As my reasons are the same, I beg leave to make use of the words of Cicero to his friend, *teneri non potui quin conjunctionem studiorum amorisque nostri, quo possem literarum genere, declararem.*

You best know the usefulness of such a work, will be pleased with

the design, and candidly excuse my failings. The *writers*, from whom I have made these extracts, stand high in the list of fame; and by the general voice of Europe, are exceeded only by some of *our own*: it gives me an additional pleasure to find that many of them were physicians, not eminent perhaps in practice, but such as had more extensive views, of being useful to their own and future ages.

Mr. De Fontenelle in his *elogiums* of some of *them* hath very prettily as well as justly observed that “ a physician, in order to be in vogue, hath often as much to do with the fancies of his patients, as with their lungs or liver; and he must know how to physic the fancy, which requires particular specifics.”

Those *nostrums* for pleasing the fancy and humouring the caprices of others are frequently not known, but most commonly, disdained by the truly able and honest physician.

It

DEDICATION.

It must be acknowledged in honour to the memory of Lewis XIV, that although he oppressed religion, he raised science, and surely he could not have taken a more effectual method for extirpating superstition and introducing a reformation; for true religion and science have a necessary connection and dependance.

Had the same encouragement been continued which he begun, and in consequence of it the same ardour and spirit survived in all ranks and orders of men for acquiring knowledge; it is highly probable that by this time there would have been such an universal light of truth, that superstition would scarce have had a gloomy convent to retire to. But with the death of Lewis these hopes expired, new schemes of politics arose, the encouragement of sciences began to droop, and though a few have distinguished themselves by a force of genius, yet the generality of

the people have relapsed into their former ignorance.

The decay of the politer arts and sciences from the death of Lewis is easily observable in every species of writing; no more the *numbers* of a Boileau, the *comic humour* of a Moliere, or the *tender scenes* of a Racine. From that period also I can discern a kind of *blight* upon the fruits of the academy, and can justly pronounce that very few have given any shining memoirs but the *veterans*, that had been formed under Louis le Grand.

That I may not exceed the bounds of an epistle I must hasten to conclude with assuring you that I am,

With the sincerest Esteem and Friendship,

Your most obliged humble Servant,

Octob. 1, 1753.

Peter Templeman.

P R E F A C E.

TH E history and memoirs of the Royal Academy of sciences are such a treasure of useful knowledge in every branch of science, that the most eminent writers throughout Europe for these fifty years past have enriched their works from this noble collection. Yet on a careful review I find a great number of useful observations, experiments, and illustrations, that have wholly escaped the notice of those writers, or did not expressly fall within the subjects they were treating of: I have therefore extracted all such curious and remarkable portions, as are of general use and importance, and have been unobserved by others, at least within the compass of my own reading.

I consider myself as a sort of gleaner after the harvest of others; the grain I pick up dispersedly *here* and *there* is of the same kind and goodness as that which they have taken by handfuls: the only difference is that my toil is the greater.

In the prosecution of this work I have omitted to make any extracts of such parts as have been extracted by others, unless in some few instances where their extracts were not sufficiently ample; and have contented myself with directing the reader to the writers, and

the places where those extracts are to be found.

Secondly, I have carefully avoided all imaginary theories, and have admitted no other reasoning than what necessarily results, or is with the highest degree of probability deducible from the experiments proposed. I cannot help observing that many of the French philosophers have so long fixed their attention on *vortices*, that their heads seem to turn and grow giddy with them; for they use that term in no determinate sense: for instance, the celebrated Mr. De Fontenelle, in speaking of a large body of fire, which he describes as having the figure of a tree and moving from west north-west to east south-east, yet calls it *un tourbillon de feu* a vortex of fire. *Vid. History 1700, pag. 10*

Thirdly, I shall not take notice of such matters as were formerly the subjects of great disputes and contests, but have *long since* been composed and universally acquiesced in. For example, in the year 1692, Mr. Mery proposed a new theory on the passage of the blood through the *foramen ovale* in the foetus, that it was not from the right auricle of the heart to the left; which was the commonly received opinion: but on the contrary, Mr. Mery insisted that the blood moved from the left auricle to the right in passing through that foramen. Mr. Du Verney rose up in defence of the common opinion immediately after the renewal of the academy, and to bat-
tle

tle they went; a great part of comparative anatomy was taken in for auxiliaries. The war lasted several years with great fury, and even ill manners on both sides: the Academy was obliged to interpose, and deputed proper persons to examine into the truth of facts alleged by the parties; and altho' she decided some points of fact in favour of Mr. Mery, yet the main of the question was left undecided. Even so far as the year 1717, Mr. Winslow appears rather wavering in his opinion.

I have mentioned this question particularly, because few I believe know that it was once the subject of mighty heats and controversies. It is in the philosophical as in the greater world, the peaceful *inhabitant* of the present times enjoys his shades and arbours without reflecting, or perhaps knowing, that they were *once* the scenes of wars and tumults.

I should not be surpris'd if after a certain course of years, *this* as well as many other *now sleeping* disputes should arise. We often find some enterprising genius in philosophy, like an ambitious prince, reviving old pretensions, new furbishing rusty armour, and endeavouring to disturb the present possessors from the quiet enjoyment of their opinions. Indeed whoever converses much with old books will find that what are called new discoveries are in general only old opinions revived. I could exemplify it by many instances,

P R E F A C E.

ces, but it would perhaps be an invidious task, and is beside my present subject.

The veracity and credit of the academy is so well established, that I am satisfied, with regard to facts and experiments recorded in the history and memoirs, their testimony may be considered as indubitable. And as an evidence of it I beg leave to cite the 25th article of the original statutes of the academy.

XXVth ARTICLE.

All experiments that shall be reported by any gentleman of the academy shall be performed by him in the assembly, if it be possible; or at least they shall be so in private in the presence of some of the academy deputed for that purpose.

The number of volumes now published by the academy is so great that few would be at the expence of purchasing, or at the pains of reading them. I hope therefore that the labour I have bestowed on them will be candidly received.

I shall add nothing more than to bespeak the favour of the public by assuring them that my whole ambition is to be useful, and that I shall dedicate my small abilities, and all the time, which an ill state of health will afford, to their service.

N. B. The edition, to which the references are made, is the Paris edition in quarto.

CONTENTS

OF THE FIRST VOLUME.

	Page
O <i>F</i> hot mineral waters — — —	1
<i>Why a vessel containing water that boils, is not hot at the bottom?</i> — — —	2
<i>Why water can acquire no greater heat than that of boiling?</i> — — —	4
<i>Of water frozen</i> — — —	5
— <i>Dissolves faster in vacuo</i> — —	ibid.
<i>Remarkable thickness of ice</i> — — —	ibid.
<i>An observation on fluidity</i> — — —	6
<i>Of petrifying waters</i> — — —	ibid.
<i>A remarkable effect from water</i> — — —	7
<i>Earthquake at Smyrna</i> — — —	8
<i>Earthquakes in Italy</i> — — —	10
<i>Earthquake at Lima</i> — — —	13
<i>Vulcanos, Earthquakes, hot mineral waters, &c. explained experimentally</i> — — —	14
<i>The particles of air not easily separable</i> — — —	16
<i>Vipers and frogs live in the exhausted receiver</i> — — —	18
<i>The resistance of air and water to sudden motion</i> — — —	19
<i>Instances of early ripeness in a boy and a girl</i> — — —	ibid.
<i>Remarkable youth of two old women</i> — — —	20
<i>Terrible effects from corrupted rye</i> — — —	ibid.
<i>The horizontal moon solved</i> — — —	21

C O N T E N T S.

	Page
<i>A peculiar kind of serpent in Brazile</i>	22
<i>Remarkable case of a man born deaf</i>	24
<i>A remark on the thermometer</i>	25
<i>An uncommon phenomenon of the barometer</i>	27
<i>A curious observation on the burning-glass</i>	31
<i>A remarkable cure of a delirium by music</i>	32
<i>Another</i>	34
<i>A remark on the giving suck to children in Batavia</i>	36
<i>The usefulness of ants at Surinam</i>	ibid.
<i>An uncommon meteor in the air</i>	37
<i>A remarkable storm of hail with its consequences</i>	38
<i>A curious petrified bee-hive</i>	39
<i>Petrified fish</i>	41
<i>Of petrification and origin of stones</i>	42
<i>Of the roundness of stones</i>	51
<i>The preceding theory confirmed by an experiment of artificial stone</i>	54
<i>Observation on flint quarries</i>	55
<i>Of the progressive motion of several sorts of shell-fish</i>	ibid.
<i>Of the sea-muscles</i>	57
<i>Of river muscles</i>	69
<i>Of the lavignon</i>	72
<i>Of the star-fish</i>	74
<i>Of the sea urchins</i>	77
<i>Of the urtica marinæ, or sea-nettles</i>	79
<i>Of the lepas, or limpet</i>	80
<i>Of the razor, cutler, or sheath-fish</i>	88
<i>Surprising lustre of dails, or dottle fish</i>	90
<i>Remark on the glow-worm</i>	96
<i>Of the razor, cutler, or sheath-fish</i>	97
<i>Of the pinna marina</i>	99
<i>Of the purple of the ancients</i>	101
<i>A new purple discovered</i>	110
<i>The surprising production of soles from shrimps or prawns</i>	119
<i>The</i>	

C O N T E N T S.

	Page
<i>The wonders in crawfish, lobsters, crabs, &c.</i>	121
<i>Of bezoard stones and pearls</i>	136
<i>A singular species of aquatic worm</i>	143
<i>A remarkable talking dog</i>	147
<i>On the prints of plants on certain stones</i>	149
<i>A large district of country overwhelmed by sand</i>	158
<i>A storm of sand</i>	159
<i>Of thunder-bolt stones</i>	ibid.
<i>An useful observation with respect to the mad dog</i>	161
<i>Observations on communicating the magnetic virtue to workmens tools</i>	162
<i>A remarkable loadstone</i>	173
<i>A new discovered property in iron</i>	ibid.
<i>Of the specific differences of earths</i>	176
<i>Of wasps</i>	185
<i>Of moths</i>	221
<i>Methods of destroying moths</i>	238
<i>A surprising account of two toads</i>	251
<i>The manner of preserving eggs fresh for several years</i>	254
<i>Curious experiments on the effects of the pressure of water at different depths in the sea</i>	259
<i>Natural curiosities observed in a voyage to the polar circle</i>	260
<i>Observations of natural curiosities at Peru</i>	284
<i>Natural curiosities observed in the course of the river of the Amazons</i>	312
<i>A discovery of the male toad performing the office of a man midwife to the female</i>	371
<i>Of insects that multiply without the conjunction of sexes</i>	374
<i>An account of an inflammable rivulet</i>	377
<i>A new theory of the evaporation of liquids</i>	379
<i>An explication of the phenomenon of the tides in the lake of Geneva</i>	382
	Of

C O N T E N T S.

	Page
<i>Of the spaying of fish</i> — — — —	390
<i>Observations on Mr. Hales his account of the freezing of rivers</i> — — — —	392
<i>A new discovery in optics</i> — — — —	404
<i>An observation of the different effects of the heat of the sun on metals and animal bodies</i> — —	405
<i>The conformity between electrical matter and elemen- tary fire</i> — — — — —	406

D I R E C T I O N S to the Book-binder.

Place	Plate	1st fronting	Page
	1st	fronting	68
	Plate 2d	— —	78
	Plate 3d	— —	104
	Plate 4th	— —	194
	Plate 5th	— —	205
	Plate 6th	— —	282
	Plate 7th	— —	368

GENERAL PHYSICS.

THE heat of mineral waters doth Of hot mineral waters. not arise from a real and actual fire; for they neither scald the tongue nor soften vegetables, as common water heated to the same degree would do; and when put on the fire they do not boil the sooner for being already hot.

*History tom. 1st, anno 1667, pag. 33,
and Memoirs anno 1707, Pag. 113.*

The water of Balaruc in Languedoc, seems to the touch almost as hot as common water that is ready to boil; yet a new laid egg, that has been in it $\frac{3}{4}$ of an hour, has been no more altered, than if it had been in cold water.

History anno 1699, pag. 55.

The water of Bourbon put on the fire doth not boil so soon as common water that is cold; the heat that it hath of itself is an obstacle to its acquiring a new heat. When the hot water of the fountain, and com-

mon cold water have boiled on the same fire, where they have continued the same time; that of the fountain grows cold somewhat sooner; whereas it grows cold somewhat slower than common water heated to the same degree, when it hath not boiled.

History anno 1724, pag. 47.

Why a
vessel
contain-
ing water
that boils,
is not hot
at the
bottom?

The question was started one day occasionally, Why a vessel full of boiling water hath the bottom less hot during the moment that the water, taken off from the fire, still continueth to boil, than when it hath ceased to boil? For whilst the water still boileth, one may touch with the hand the bottom of the vessel without being burnt, and one cannot do it immediately after the water hath ceased to boil. It is necessary to add, that for the success of the experiment, the bottom of the vessel must be thin, and the vessel pretty large.

Mr. Homberg said upon it, That he conceived a body to be hot only in consequence of its being pervaded in all directions by the matter of flame, which issuing from all parts with impetuosity, like an infinite number of little poignant darts, carried into all other bodies, where it darted itself, the impressions of heat; that when a vessel is on the fire, the flame, being urged upwards by the gravity of the air, endeavoured to open

open itself passages into the water of the vessel according to that direction; that at first it must find difficulty to penetrate this water, into which there were no roads, such as its motion required; that at last it made itself roads, and in that state the water boiled; that then all the passages from below, upwards through the water, being easily pervaded, the flame, that struck incessantly the bottom of the vessel, went through them without any difficulty; that by consequence, the vessel being taken from the fire, the motion of all the little darts at that instant was from below upwards, and that they could not hurt the hand which touched the bottom of the vessel; but that when the water ceased to boil, all its parts, being less agitated, sinking, and falling back one upon another, closed a great number of passages that before were open, which obliged the little darts to escape indifferently all manner of ways; and that by consequence the hand, which was applied to the bottom of the vessel, must receive a great number, and be wounded by them.

The bottom of the vessel is considered *here* only as a simple surface, which the flame barely passes through before it arrives at the water, and on which it no longer acts: But if the bottom hath any thickness that is considerable, the flame *then* acts necessarily, in pervading it, not only from

below upwards, according to the direction given to it by the gravity of the air, but from above downwards, and in all directions, because it is reflected by the solid parts; and from thence it is that in that case, independently of the different states of the water, the hand will always perceive heat in touching the bottom. If the bottom is thin and at the same time the vessel is narrow, the sides of the vessel that surround the bottom will communicate to it their heat; and consequently the vessel cannot be too large, no more than its bottom too thin.

History 1703, pag. 24.

Why water can acquire no greater heat than that of boiling.

The preceding little system on heat hath furnished likewise Mr. Homberg with the reason of a very surprising fact, which Mr. Amontons hath discovered in making his thermometer, and which hath been of use to him in its construction. This fact is, that when water boils as much as it can boil, its degree of heat increases no more, although it be kept longer on the fire, or on a more intense fire.

The water, according to Mr. Homberg, is hot, or boils, only in consequence of its being pervaded by the matter of flame, which puffs it up, raises it, and makes its surface rough and uneven; when this matter hath made itself every where free passages through the water, the water boils as much

much as it is capable of boiling, and the matter of flame can effect nothing more; thus whether new matter succeeds continually, or whether it comes in greater abundance, it can neither more completely open the passages, nor open a greater number of them.

Ibidem.

Water is the only fluid that in freezing ^{Of water frozen.} increases in bulk, and becomes lighter. Mr. Homberg hath attempted to discover the reason of it, having drawn away the air with extreme care from a quantity of water, which he exposed afterwards to a strong freezing; he had a piece of ice entirely transparent, and without any bubble; he had marked the height of the water in the vessel; by being frozen it had not enlarged, it had rather contracted a little.

History tom. 2. anno 1693, pag. 170.

The same gentleman hath discovered that ice dissolves much faster *in vacuo*, than in ^{Dissolves faster in *vacuo*.} the open air; the difference was nearly one third of the time.

Ibidem.

In the winter of 1709, the ice of Copenhagen harbour was 27 inches thick in those places where flakes of ice were not heaped one upon another. This fact is so much the more observable, as in the great frost of 1683, the Royal Society having caused the ice of the Thames, when coaches

^{Remarkable thickness of ice.}

went upon it, to be measured, it was found to be no more than 11 inches thick.

History 1709, pag. 10.

An obser-
vation on
fluidity.

It is highly probable, says Mr. Fontenelle, that the matter of fire causes the fluidity of all that is liquid; since it is very certain that it makes the fluidity of a metal that is melted, why may it not be supposed to make *that* of water likewise? Is water any thing but ice melted? It is almost indubitable, that in the planet Saturn, our water would be for ever solid ice, or stone; and that in Mercury our metals would be for ever fluid.

History 1712, pag. 45.

Of petri-
fying wa-
ters.

Father Duchatz relates that the river, which passes by the town of Bakan, in the kingdom of Ava, hath in that place, for the space of 10 leagues, the virtue of petrifying wood; and that he himself had seen there great trees petrified quite to the surface of the water, all the rest still remaining a dry wood. This petrified wood was as hard as a flint stone.

Memoirs tom. 10. anno 1692, pag. 143.

At Clermont in Auvergne there is a petrifying spring; from the chemical trials of it by Mr. Lemery, it appears to contain an acid, which probably hath dissolved some stony substance, from the places through

through which it has run. This petrifying water is not *from thence* more dangerous for drinking. In effect, stones and what are called stones of the bladder have nothing a-kin.

History 1700, pag. 58.

At Senlisses a village near Chevreuse, situated in a valley at the bottom of a hill, there is a public fountain, the water of which causes the teeth to fall out without any flux of spitting, without any pain, and without any bleeding. This effect can be attributed to nothing else, for the air is very good and very temperate, the inhabitants more robust and healthy than elsewhere; only more than half of them are without teeth. At first the teeth shake in the mouth for several months, like the clapper in a bell, and afterwards fall out of themselves. The water that is accused for this malady is a constant stream, and very cold when drank as it issues from the fountain; it is found to be an hard water when used for dressing victuals; and it is said to give the gripes to those that have not been accustomed to it. Mr. Aubry, the clergyman of the place, sends word, that he had been advised no longer to use it without boiling it first, which would cause the ill quality of it to evaporate.

A remarkable effect from water.

Mr. Lemery having examined it in all ways, and put it to all the chemical trials, has not been able to discover any thing particular in it: upon a gallon which he caused to evaporate by a gentle fire, there remained 12 grains only of a fixt alkali salt, which appears a very trifle with regard to so great a quantity of water. The cause of the bad effect of the fountain of Senliffes is therefore something too subtil and delicate, to be discovered by our senses.

Vitruvius speaks of a fountain at Susa, in Persia, whose water caused the teeth to fall out in those that drank it; and it is very remarkable that Mr. Lemery hath seen at Paris, a Persian, born at that city Susa, who took, when he would, 7 or 8 teeth out of his mouth, and put them in again as easily. It is true that he had the scurvy to a violent degree. Perhaps the fountain of Senliffes would occasion the scurvy likewise, if the goodness of the air, and other favourable circumstances did not oppose it.

History 1712, pag. 23.

Earth-
quake at
Smyrna.

Mr. Galand came to the assembly of the academy the 1st of December 1688, and there gave a circumstantial account of the earthquake that had been felt at Smyrna and in the neighbourhood on the 10th of July preceding. There had been felt a shock of another earthquake on the 18th of December

cember 1687, but which was of no consequence; the last began at $\frac{3}{4}$ after 11 in the morning with a motion from west to east; the castle was at once demolished, its four walls having gaped open and sunk down 6 feet into the sea. This castle, which was an isthmus, is at present a perfect island, distant from the shore about an hundred paces in the place where the neck of land hath been cut off. The walls which were from west to east are fallen, those that were north and south are still standing.

The city, which is 10 miles distant from the castle, was almost immediately ruined; in several places were seen openings in the earth, and divers subterraneous noises were heard; there were 5 or 6 shocks of the like kind before night, the first lasted about half a minute.

The fire caught the greatest part of the houses of the town, excepting in the Turks quarter, who at that time kept their *Ramasan*, or solemn fast, and for that reason had no fire in their houses. Mr. Galand was himself enveloped, and as it were buried under the ruins of an house for $\frac{1}{4}$ of an hour. The ground hath sunk 2 feet in the town, and it is necessary at present to descend, in order to go to certain places on the sea shore, where before it was necessary to ascend. There hath remained no more than

than $\frac{1}{4}$ of the town, and that principally of those houses which were situated on rocks.

In those parts there blows constantly during the summer a westerly wind, which begins about 10 in the morning, and continues increasing till 4 in the afternoon; and in the same season the northerly winds, called the *Tramontanes*, are very common in the Archipelago.

On the 11th and 12th, that is to say, the two following days, and on the 11th of August the earthquake began again about 8 in the morning: At length on the 10th of September was perceived a violent stench of sulphur: At the same time were felt earthquakes at Metelin, Chio, Satalin, and along the coast. In the night between the 10th and 11th, there was felt *one* at Constantinople. Mr. Galand had been informed that there had been found *since* springs of water quite new. During all these confusions the air was very thick and hot, and the northerly wind very sultry. They reckon that fifteen or twenty thousand persons were destroyed by this earthquake. The last that ravaged Sicily did not cause any thing near such havock, nor had so long a continuance.

Tom. 2. anno 1588, pag. 37.

Earth-
quakes in
Italy.

Mr. Maraldi communicated to the Academy some accounts he had received of the

the earthquakes that had happened in Italy.

The earthquakes began in Italy in the month of October 1702, and continued to the month of July 1703. The countries that have suffered the most, and which were those likewise where they began, are the city of Norcia, with its dependencies in the ecclesiastical state, and the province of Abruzzo: These countries are contiguous, and situated at the foot of the Apennine on the south side.

The earthquakes were often attended with dreadful noises in the air, and often likewise those noises were heard without any earthquakes, the sky being very serene. The earthquake of the 2d of February 1703, which was the most violent of all, was accompanied, at least at Rome, with a great serenity of the sky, and a great calm in the air: It lasted at Rome half a minute, and at Aquila the capital of Abruzzo three hours. It ruined the whole city of Aquila, buried 5000 persons under the ruins, and made a great havock in the neighbourhood of it.

The nutations of the earth were commonly from north to south, or nearly so, which was remarked by means of the motion of the lamps in churches. There were in one field two openings made, from whence there issued with violence a great quantity

quantity of stones that entirely covered the field, and have rendered it barren : after the stones there darted forth two water spouts, that exceeded in height the trees of that country, continued a quarter of an hour, and overflowed the country all about. This water is whitish, resembling soap and water, and hath no taste.

A mountain that is near Sigillo, a town 22 miles distant from Aquila, had on its summit a pretty large plain surrounded by rocks, which were like walls to it. Since the earthquake of the 2d of February, there hath been in the place of that plain a gulf of an unequal breadth, the greatest diameter of which is of 25 fathom, and the least of 20 : no bottom to it can be found, although they have searched 300 fathom deep. At the time that this opening was made, flames were seen to issue out of it, and afterwards a very thick smoke, which lasted three days, with some intermissions.

At Genoa, on the 1st and 2d of July 1703, there were two little earthquakes; the last was felt only by people at work on the mole; at the same time the sea sunk in the harbour 6 feet, and this sinking lasted near a quarter of an hour.

The sulphureous water, that is in the road between Rome and Tivoli, is diminished 2 feet and $\frac{1}{2}$ in height, as well in the basin, as in the fofs. In several places
of

of the plain, called the *Testine*, there were springs and rivulets of water that formed unpassable morasses. All is now dried. The water of a lake called *Hell* is diminished likewise 3 feet in height. In the room of the former springs, which are dry, there have issued out new ones about a league distant from the first, in so much that it is probable they are the same waters which have changed their course.

History 1704, pag. 8.

On the 28th of october 1746, there was Earth-
heard at Lima, at about half an hour after quake at
10 in the evening, a subterraneous noise, Lima.
which precedes always, at least in that country, the earthquakes, and lasteth long enough for people to get out of their houses; the shocks came afterwards and were so violent, that in 4 or 5 minutes time there did not remain of all that capital above 20 houses standing; seventy-four churches or convents, the palace of the vice-roy, the royal audience room, the hospitals, the courts of judicature; and all the public edifices that were more lofty and more solidly built than others, were ruined quite to the ground.

Callao a fortified town, and the port of Lima, at 2 leagues distance from that capital, was demolished, probably by the same shocks, at the same time, when the earthquake was perceived. The sea retired from the

the shore to a great distance, it returned back again with so much fury, that it overwhelmed 13 of the vessels, which it had left stranded and lying along side in the port, carried away 4 very far into land, whither it extended itself a full French league, sweeping away entirely the town of Callao, and swallowing up all its inhabitants to the number of five thousand, besides several of the inhabitants of Lima whom it caught on the road. The oscillations that the sea made till it had resumed its natural bed, covered the ruins of that unhappy town with so much sand, that there scarce remains any mark of its situation. There had been already found 1141 bodies buried under the ruins, when the vessel set sail that hath brought this intelligence. They were at work in rebuilding the houses of Lima, making them still lower than they were before this accident; and it was hoped that, by the prudent precautions of the vice-roy, they should be able to get out of the ruins the greatest part of the valuable effects that were there buried.

History 1746, pag. 24.

Vulcanos,
earth-
quakes;
hot mine-
ral waters,
&c. ex-
plained
experi-
mentally.

Mr. Lemery hath made an artificial Etna or Vesuvius, having buried in the earth a foot deep 50 pound-weight of a mixture of equal parts of filings of iron and sulphur in powder, the whole reduced into a paste with

with a little water. At the end of 8 or 9 hours the earth began to heave, and opened in several places, sulphureous and hot vapours issuing forth, and at length flames. It is very easy to conceive, that a greater quantity of this mixture of iron and sulphur with a greater depth of earth, was all that was wanting to make a real Etna.

This operation succeeds better in summer than in winter, on account of the heat of the sun, which excites a greater intestine motion in the imperceptible parts of the iron and sulphur.

But *here* starts a difficulty, which is, that these great fermentations and subterraneous conflagrations could not be produced without air: Now it is not easy to conceive by what conveyance the air could pass so deep beneath the earth. Mr. Lemery replies to this objection, that there are in the earth many clefts and passages which are not commonly seen, and principally in the hot countries, where these subterraneous commotions most commonly happen; for the great heat of the sun calcining in a manner the earth in several places, causes in it deep crevices, through which the air may be introduced. The earthquakes probably are caused by a vapour, which having been produced in the violent fermentation of the iron and sulphur, is converted into a sulphureous wind, that makes itself a passage,
and

and rowls where it can, lifting up and shaking the ground under which it passes. If this sulphureous wind continues confined, without being able to open itself a vent to escape, it causes the earthquakes to last a long time, and with great efforts, until it hath spent its force. But if it finds any openings to issue at, it darts out with great impetuosity, and makes what is called an hurricane.

Hot mineral waters, such as those of Bourbon, Vichi, Bareluc, Aix, have probably taken their heat from sulphureous earths through which they have passed; for when these waters are at rest, there separates from them *sulphur* to the sides of the vessels containing them.

The water-spouts which rise sometimes at sea, and which are to sailors the sad presages of a sudden shipwreck, are owing probably to these sulphureous winds, forced rapidly from the earth, beneath the sea, after such fermentations as we have been speaking of.

*History 1700, pag. 51, and Memoirs,
pag. 104.*

The particles of air not easily separable.

Air is not very easily separated from other air. If the neck of a bottle hath less than 4 lines in diameter, it may be filled with water and turned topsy-turvy, without a drop of water issuing from it; because the
air,

air, which must enter at one side of the neck whilst the water issues at the other, is not easily separated into such small parcels as is requisite. In like manner a bottle that is empty, and whose neck should be of the abovementioned diameter, would continue at the bottom of a vessel full of water, without a drop of water entering into it; and what is very surprizing, this would not happen if the bottle was full of wine well refined, and lighter than water; for then the water would fall into the bottle and cause the wine to rise out of it. It follows therefore that wine, though much more heavy and more gross than air, is much more easily divided into small parcels.

History tom. 1. anno. 1679, pag. 271.

N. B. *From this experiment Mr. Senac explains the reason why, though the epiglottis be raised, water will not enter into the lungs of those that are drowned.*

Vid. history 1725, pag. 13.

The difficulty of separating the particles of air appears likewise from hence. In solutions of salts or metals we see bubbles of air rise from the bottom of the liquor quite to the top, loaded with saline or metalline particles. When the bubbles are arrived at the top, they unite themselves to the external air, and the particles which they had raised fall

back again : as these particles are specifically heavier than the air, it cannot raise them but by attaching itself to them with a certain force, and in such manner that the whole mass must be lighter than the liquor that it traverses in mounting. Now in this *little whole*, the quantity of air must be of a greater bulk than the saline or metalline particle, for otherwise the whole mass would not be sufficiently light to ascend. From thence it follows that the particle which is raised is not attached to all the air that raises it, and consequently it tends by its weight to separate the parts, to which it is adherent, from those to which it is not adherent; and since it doth not separate them the one from the other, they must have a certain union together that prevails over that effort.

History 1731, pag. 2.

Vipers
and frogs
live in the
exhausted
receiver.

Neither the viper nor the frog die, although the air hath been pumped out of the vessel wherein they are included, as Mr. Homberg hath often made the experiment before the gentlemen of the academy.

Memoirs tom, 10th, anno 1693, pag. 397.

N. B. By Mr. Boyle's experiments they died, but not 'till after many hours.

Vid. Boyle's works, vol. 3. pag. 115.

This

This difference may be owing probably to this, that Mr. Boyle's exhausted receiver made a more perfect vacuum, than that of the academy.

Mr. De la Hire observes, that the resistance to motion is by so much the greater, as the motion is more sudden; and when it is so, to such a degree that what resisteth hath not the time to recede, then a body very weak of itself may supply the place of one that is unmoveable, and of an invincible obstacle. It is for this reason that air and water, struck with such velocity, and with so sudden a blow, that they have not time to recede, become fixed points, the one for the flight of birds, the other for the action of oars.

The resistance of air and water to sudden motion.

History 1702, pag. 11.

A magistrate of Besançon hath sent word to the academy, that there was near mount St. Claude a boy, that at the age of six months began to walk; at 4 years old he appeared capable of the act of generation; at seven years of age he had a beard, and the stature of a man; he was then ten years old when the magistrate sent this account.

Instances of early ripeness in a boy.

History tom. 2. anno 1695, pag. 234.

A suitable match for that boy, bating in point of time, was a girl whom Mr. De Langlade, a surgeon of Carcassone, hath sent

In a girl.

word to Mr. Du Verney, that he had seen in his own country; she was born the 8th of February 1704, had her courses 8 days, or according to other accounts, 3 months after her birth; she was then, at the age of a little more than 4 years, 3 feet and half high; all the body well proportioned to her height, the breasts and the parts of generation as in a girl of 18, insomuch that she appeared perfectly marriageable. Mr. De Langlade had made with care all the observations necessary. Girls in the East-Indies which travellers assure us have children by 9 years old cease to be a wonder.

History 1708, pag. 52.

Remark-
able youth
of an old
woman.

The same Mr. De Langlade hath sent word likewise, that a physician had very lately assured him that he had seen a woman 106 years old, who had still her courses.

Ibidem.

Another
instance.

The late bishop of Sees, declared that a man of his diocese, and whom he knew, 94 years old, had married a woman of 83, with child by him, who was brought to bed of a boy at her full time.

History 1710, pag. 16.

Terrible
effects
from cor-
rupted rye,
in a letter
from Mr.
Dodart.

Some years ago Mr. Perrault gave an account to the academy, that in passing through Sologne, he had heard from the physicians and

and surgeons of the country, that the rye was sometimes corrupted in such manner, that the use of the bread, into which much of that corrupted grain had entered, caused to fall off mortified from *some* one part, from *others* another; and that one for example lost a finger, another an hand, another his nose, &c. And that this gangrene was not preceded either by fever, inflammation, or considerable pain, and that the gangrened parts fell off of themselves, without any need of being separated by any applications.

Memoirs tom. 10. anno 1676, pag. 561.

N. B. The rest of the account being cited, and fully represented, in the philosophical transactions, (Vid. Lowthorp's abridgement, vol. 2d, pag. 625.) I need not make any further extract of it.

Father Gouye conjectures that, when the moon is in the horizon, the proximity of the earth, and the denser vapours, with which that luminary is *then* enveloped in respect to us, produce the same effect as a wall placed behind a column, which appears then much bigger than if it stood alone, and environed on all sides by a clear air. Again, a column if it is *fluted* appears bigger than when it is not *so*, because the flutings are so many particular objects, which by their multitude give room to imagine that the total object which

The horizontal moon solved.

C 3 they

they compose is of a greater size: of the like kind and efficacy are all objects that lye spread on that part of the horizon, to which the moon corresponds, when she is near it; and from thence it is that she appears much larger when she rises behind trees; the more close and distinct intervals of which produce almost the same effect on the apparent diameter of this planet, as a greater number of flutings on the shaft of a column.

History 1700, pag. 9.

A peculiar
kind of ser-
pent in
Brazile.

Mr. Couplet, the younger, in a letter to the Abbé Bignon, president of the academy, says, I could never cast my eyes on those astronomical observations, that I made at Pariba, without recollecting an accident that happened to me there at the same time. As I believe no author hath spoke of the like kind of thing, you will perhaps be well pleased to see it here. There is in Brazile a sort of serpent about 2 feet long, and between 3 and 4 inches round, which the Portuguese call the two headed adder, not that it really hath two heads, as I have clearly perceived after examining it with care, it hath only at the end of the tail a *bigness*, which hath at a distance some resemblance of an head. The Brazilians, and after them the Portuguese, have been the more easily induced to take it for an head, as they are extremely fearful of this kind of adder, to the sting of
which

which they pretend there is no remedy. They know likewise that it is dangerous to touch it after it is dead, and probably that has hindered them from examining it. They gave me warning that the touching it alone would occasion a scab; I neglected an advice so salutary, which I considered as an effect of their timorousness, but I was punished for my rashness; for having killed several of these adders, I skinned some of them in order to examine them, and to preserve their skins; two or three days after I found myself quite covered with pustules, that were full of a red water; they lasted on me a long time; and even three months after I was not entirely rid of them.

There are in the country adders of an extraordinary bigness, I killed one of them with a musket shot in the woods between Paraiba and Pernambouc, which was more than 15 feet long, and between 16 and 18 inches round; it was all covered with scales, black, white, grey, and yellowish, which all together had a very pretty effect. The bite of these adders is venomous; nevertheless the Brazilians and the blacks make no difficulty of eating their flesh. This need not appear more strange than what is observed in the Manioc, of which a kind of bread that is made is the most common aliment in Brazile, and the juice of which is a poison, as I experienced on a Terrier dog, to whom

I gave less than half a wine glass of it about 8 in the evening. I observed the dog for some time, without remarking any sensible change in him; I shut him up at night, and the next morning I found him dead.

Memoirs 1700, pag. 177.

Mr. Felibien, a member of the academy of inscriptions, hath sent an account to the academy of sciences, of a singular event, perhaps never before heard of, that hath just happened at Chartres.

Remarkable case of a man born deaf.

A young man between 23 and 24 years old, a tradesman's son, deaf and dumb from his birth, began all of a sudden to speak, to the great amazement of the whole town. They learnt from him that 3 or 4 months before he had heard the sound of the bells, and had been extremely surprized at this new and unknown sensation. After this there had come away a kind of water from his left ear, and he heard perfectly with both ears: he continued those 3 or 4 months to listen without saying any thing, accustoming himself to repeat aside the words that he heard, and confirming himself in the pronounciation, and in the ideas affixed to the words. At length he thought himself in a condition to break silence, and he made known that he spoke, though it was yet but very imperfectly. Able divines soon enquired of him concerning his past state, and their principal questions

were concerning God, the soul, and the moral good and evil of actions: he did not appear to have carried his thoughts so far; although he was born of catholic parents, was used to be present at mass, was instructed to make the sign of the cross, and to kneel with the countenance of a man at devotion, he had never joined to all That any intention, nor comprehended what others joined to it; he did not very distinctly know what death was, and had never reflected on it; he led a life purely animal, entirely taken up with those objects that immediately struck his senses, and with the few ideas that he received by his eyes; he did not even infer, from the comparing those ideas, all that one would think he might have inferred. This is not owing to his not having naturally a good understanding; but the understanding of a man, deprived of the commerce of others, is so little exercised, and so little cultivated, that he thinks no more than what he is indispensibly forced to by external objects; the great fund of the ideas of men is in their reciprocal commerce.

History 1703, pag. 18.

It must appear very surprising that, when the ball of a thermometer is covered with the hand, in order to warm the liquor included, and to make it ascend in the tube, the liquor at first sinks down, and does not ascend

A remark
on the
thermo-
meter.

ascend above its former level 'till after that motion, so irregular in appearance, and so contrary to what one would have expected. Mr. Amontons, who spoke of it on occasion of his new thermometers, imputes this motion, in which the liquor sinks at first, to the rarefaction, that the warmth of the hand occasions in the substance itself of the glass of the ball, before it causes any in the liquor. The capacity of the ball increases therefore, and of consequence the liquor of the tube descends, 'till it hath got sufficient heat to mount upwards, notwithstanding the enlarged capacity of the ball.

On the contrary, the application of snow to the ball of the thermometer, causes the liquor at first to ascend in the tube.

Vid. tom. 2. anno 1684, pag. 394.

Mr. Amontons hath calculated upon very exact experiments, how much the capacity of the ball was enlarged, and hath found it to be no more than a thousandth part. This thousandth part, in which the ball is enlarged, and which is the quantity of liquor that enters it, or that sinks, will become so much the more perceptible on the tube, as the capacity of the tube shall be smaller in proportion to that of the ball.

History 1704, pag. 11.

In

In the year 1705, there was mentioned in the academy an uncommon appearance of a barometer, that belonged to the lord chancellor, which kept 18 or 19 lines lower than all other barometers, and greatly surprized the whole academy; when it was inclined, and the mercury was made to rise to the top of the tube, it was exactly filled, and not a bubble of air was to be seen; from whence it was concluded necessarily that the vacuum was perfectly well made, and that there did not remain any air that could keep the mercury lower than it ought to be; and by trying the tube with other mercury as well as by putting that mercury into another tube, it was plain there was no fault in the mercury. Divers opinions were then proposed in the academy, and the conclusion was that experiments should be made. Mr. Maraldi hath since made them, and they all confirm the conjecture of Mr. Homberg, who imagined that the lord chancellor's barometer kept lower than others, because he recollected that before it was filled with mercury it had been washed with spirit of wine. He supposed that some little drops of the spirit of wine had remained, which, when the vacuum was made, being extremely rarefied, had depressed the mercury; whether they depressed it of themselves, or whether the air which they contained, being disengaged by their rarefaction, depressed it, he did not determine.

An uncommon phenomenon of the barometer.

By Mr. Maraldi's experiments it appeared that the washing the tube with the spirit of wine, though it was well wiped afterwards, constantly produced this effect. In different experiments the difference of the height varied from 6 to 18 lines.

It is remarkable also that by the same gentleman's experiments it appeared, that if a tube hath been washed with the spirit of wine the mercury keeps lower in it, than if the same tube had been washed with brandy; and if it hath been washed with brandy, the mercury keeps lower in it, than in a tube washed with water. If, however, the tubes washed with these different liquors, have been afterwards well wiped and well dried, the mercury keeps in them at the height it was before they were washed. To dry perfectly tubes, that have been washed with spirit of wine, it is sufficient to leave them exposed for several days to the air, provided that it is not moist.

Upon the whole, no other reason can be imagined, but that the little drops of liquor, which have moistened the inside of the tube, being rarefied *in vacuo*, or that the air confined in those liquors, being disengaged from them, cause the mercury to sink. The first notion is the least probable; because if the spirit of wine by itself depressed the mercury, it would depress it *less* than the brandy, seeing that it is less heavy; and brandy, being
less

less heavy than water, would depress it *less* likewise; but by Mr. Maraldi's experiments the contrary holds true. It follows, therefore, conformably to the second notion, that there is more air contained in the spirit of wine than in the brandy, or that the air disengages itself more easily from it; and the same must hold with regard to brandy compared with water. It is true the difficulty objected to it by the late Mr. Amontons still remains; who opposed to this reasoning, that it was incredible that a few little drops of spirit of wine, or of water, extremely rarefied, and of consequence extremely weakened as to their spring, should yet have a force equal to 18 lines of mercury; that by inclining those tubes, where it was supposed those rarefied substances were contained, and by making the mercury rise to the top, they must have seen those same substances, recondensed by the weight of the mercury, form bubbles, like to those that air forms, had there remained ever so few in the tube; that notwithstanding nothing like this was seen; that in order for air left in the tube to depress the mercury 18 lines, there must have been left a very considerable quantity of it, and entirely disproportionate to that of the little drops, to which the same effect had been attributed. Finally, Mr. Amontons produced two new tubes, that could not be suspected of having been ever washed with water or spirit of wine,
where

where the mercury kept between 6 and 7 lines lower than in other barometers. Mr. Amontons was of opinion that there entered a subtil air through the pores of the tube; and what favoured this hypothesis of Mr. Amontons was, that having emptied and filled again with mercury the tube, which was the subject of all his experiments, he found that after *that* its difference of height from other barometers was diminished an half, and that it was no more than 9 lines lower. He supposed that the mercury in passing had left a kind of very fine filth, which had stopped up a part of the pores of the glass, or had rendered the passage of them more difficult. Several of the academy however did not admit the system of Mr. Amontons, which must render suspected an infinite number of experiments preceding, in which it had been always supposed that no glass would let any matter, capable of weighing upon mercury, to pass through it.

What is to be concluded from the whole? Nothing yet. The academy refers the decision to experiments yet further to be made, and perhaps it will require a long series of them. The academy doth not design to communicate only the history of her discoveries to the public; she thinks that she ought to communicate likewise her doubts, and shall see with extreme satisfaction,

tion, that her doubts contribute to the discoveries of others.

History 1706, pag. 1. and 1705, pag. 16.

The heat of the weather at Paris on the 6th of August 1705, was so great, that there had not been felt any thing equal to it for 36 years past. Who would not have thought that in that great heat the burning glass (which was that of the duke of Orleans made by Tschirnhaus) should have had much greater effects than at any other season? But the contrary happened; and surely such a phenomenon could not have been devised upon any system. Mr. Homberg found that the rays of the sun collected by the mirror had scarce any force, whilst the separate direct rays quite inflamed the air.

A curious
observati-
on on the
burning
glass.

The reason he imagines of so surprising a phenomenon is, that the great heat raises from the earth an infinite number of sulphureous exhalations, and that these substances on account of their being homogeneous, according to Mr. Homberg's system, with the matter of light, embarrass, stop, and in some sort absorb the rays; whether it be that they intercept absolutely a part of them, and hinder them from falling upon the mirror, or whether they produce with regard to them the same effect as a scabbard with regard to a sword, and by that means take from them their extreme subtilty, so necessary to cut through

through hard bodies immediately. This conjecture is confirmed by an experiment that Mr. Homberg hath made.

He placed between the mirrour and the focus a chafing-dish full of lighted coal, so that the rays which went to the focus passed through the vapour of this coal, and he found that the mirrour was considerably weakened by it. This was a representation of what happens in excessive hot weather, or rather is the thing itself in miniature. Moreover Mr. Homberg hath always observed, even in moderate and ordinary hot weather, that when the sun hath shone out for several days successively, the effect of the mirrour is not so great, as when it breaks forth immediately after a shower; the reason is that the rain hath precipitated the sulphureous exhalations, and purged the air.

History 1705, pag. 39.

A remarkable cure of a delirium by music.

A famous musician, a great composer, was seized with a fever, which having increased daily, became continued; on the 7th day he fell into a very violent delirium accompanied with shrieks, tears, panics, and a perpetual wakefulness, almost without any intermission. On the 3d day of his delirium one of those natural instincts, which it is said make the brute animals when sick to seek the herbs that are proper for them, made him ask to hear a little concert in his chamber.

It

It was with great difficulty that his physician consented to it. From the first tunes he heard, his countenance assumed a serene air, his eyes were no longer wild, the convulsions ceased absolutely, he shed tears of pleasure, and had *then* for music a sensibility, that he never had before, nor hath any longer now he is recovered. He was free from the fever during the whole concert, and as soon as it was finished he relapsed into his former condition. Upon this they did not fail to continue the use of a remedy, whose success had been so unforeseen, and so happy; the fever and delirium were always suspended during the concerts, and music was become so necessary to the patient, that at night he made a kinswoman that waked with him to sing and even to dance. One night particularly, when he had no body with him but his nurse, who could sing nothing but a vile ballad, he was obliged to be content with *that*, and found some benefit from it. At length in 10 days, *music* had entirely cured him, without any other aid than that of bleeding him in the foot, which was the second time of his being blooded, and was followed by a large evacuation. Mr. Dodart related this history, into the truth of which he had carefully examined; he did not mean that it could serve for an example, or a rule; but it is curious enough to see how in a man, whose very soul, as one may say, was become music by

a long and continual habitude, concerts had restored by degrees to the animal spirits their natural course. It is not probable that a painter could be cured in like manner by paintings; painting hath not the same power as music on the motion of the animal spirits, and no other art probably can equal it in this point.

History 1707, pag. 7.

Another.

The extraordinary cure we have spoke of by music is no longer a single instance; we have received another example of it from Mr. De Mandajor, mayor of Alais in Languedoc, a man of understanding and probity.

A dancing master of Alais, having fatigued himself during the carnival of 1708, with the exercise of his profession, fell ill in consequence of it, the beginning of Lent. He was seized with a violent fever, and on the 4th or 5th day fell into a lethargy, which lasted a long while. He no sooner recovered from the lethargy than he fell into a furious, but a mute delirium, in which he made continual efforts to get out of bed, threatened with the motion of his head, and by his looks, those that hindered him from it, and even all those who were present; and refused obstinately, but without speaking, all the medicines that were offered to him. It came into the thoughts of Mr. De Mandajor, who saw him in that condition, that, perhaps, music might

might a little compose the imagination that was so disordered, and he proposed it to the physician, who did not disapprove the notion, but was with reason afraid of the ridicule of the prescription, which would have been infinitely greater still if the patient had died in the operation of such a remedy. A friend of the dancing master, who had no reason to be under such prudent cautions, and who could play on the violin, took up *that* of the dancing master, and played to him on it those airs which were the most familiar to him. The by-standers thought the man more mad than he they kept down in his bed, and began to abuse him; but the patient almost immediately sat up in his bed, like one agreeably surpris'd, and wanted to figure with his arms the motions of the tunes: as his arms were held with force, he could only shew by the motions of his head the pleasure that he felt. By degrees, however, those that held his arms finding the effect of the violin, loosened the force with which they held them, and yielded to the motions he wanted to give himself, as they perceived his motions were no longer furious. At length in about $\frac{1}{4}$ of an hour he fell into a deep sleep, and had during that sleep a crisis which recovered him from all danger.

History 1703, pag. 22.

A remark
on the giv-
ing suck to
children in
Batavia.

Mr. Homberg, who was born at Batavia, acquainted the academy that the European women, who go thither, cannot give suck *there* to their own children; because their milk is so saltish that the children will not take to it; whereas the milk of the black women, though they use the same food, is sweet and sugary commonly, and therefore the black women give suck to the children of the Dutch and English. He himself was suckled by a black. The reason he imagines to be this, that when the European women remove into a climate so hot, for which they are not formed by nature, the vessels destined in them to secrete the milk become too much dilated, and let pass the salts which ought not to enter into the composition of that liquor: but that the natives of the hot countries are, by their first formation, such as they ought to be for breeding a well conditioned milk; either that the vessels which strain it are naturally more strait, and do not dilate afterwards more than they ought, or that they are of a more firm texture, and less capable of dilatation; or lastly something equivalent.

History 1707, pag. 10.

The use-
fulness of
ants at Su-
rinam.

Mr. Homberg read a letter dated the 24th of January 1701, which he had received from Paramaribo, in the province of Surinam, on the north coast of south America. Paramaribo is a Dutch colony. This letter contained

contained a singular remark with regard to natural history. There are in that country *ants*, which the Portuguese very justly call visiting ants; they march in troops, and like a great army. As soon as they appear, all the coffers, and all the chests of drawers in houses are opened for them, they enter and exterminate rats, mice, cackerlacs, which are a kind of insects in the country, and all noxious animals, as if they had a particular commission from nature to punish them, and rid men of them. If any one was so ungrateful as to molest them, they would fall upon him and tear in pieces his stockings and his shoes. The misfortune is that they do not keep, as one may say, their days of paying visits often enough; they would be welcome every month, and they do not appear sometimes for three years.

History 1701, pag. 16.

On the 7th of January, an hour before day light, there appeared to the inhabitants of Hague in lower Normandy, a body of fire so bright that it effaced the light of the moon; the inhabitants of St. Germain des Vaux, and of Auderville, two large villages situated on the sea shore, thought at first it was day light, and were very much surprized at so prodigious a brightness. This fire had the figure of a great tree, and went from west north west, to east south east. It was more than an hour

An un-
common
meteor in
the air.

D 3

day

day when it fell, and its fall was with so great a noise that the houses of those two villages shook with it. It was thought by those, that were twelve leagues distant, of Cherbourg, that it had fallen upon Valognes, and those of Valognes thought it fell on Cherbourg. But as the inhabitants of Hague only heard the noise, and felt the shock that its fall occasioned, they are the most credible witnesses on that point. It appeared to them that this flame fell into the sea, near the little island Origni, and the sight resembled *that* of a large ship on fire. The academy is obliged for the account of this phenomenon to Mr. De Senefsey, a gentleman of lower Normandy.

History 1700, pag. 10.

A remarkable storm of hail with its consequences.

Mr. Parent gave an account that, on the 15th of May, there fell about Iliers in Perche a prodigious quantity of hail, which was prodigious likewise on account of its size. The least was as big as the two thumbs, the biggest was equal to a fist, and weighed a pound $\frac{1}{4}$, and the middle size was about the bigness of hens eggs, and was the most considerable in quantity; it fell in several places a foot in height. The corn of 30 parishes was cut as if the sickle had gone through it. The inhabitants of Iliers, seeing the havock, had immediate recourse to their bells, which they sounded with so much vigour,

gour, that the cloud rent asunder over their parish, and the broken ends separated from each other, insomuch that that parish alone amidst 30 others, which had not such good bells, hath received but little damage. Mr. Parent added to the account, that as the corn at that time was but little advanced, though for the most part in ear, it threw up again a new blade, and those blades began to shoot forth little ears, which it was hoped might come to maturity. He hath *since* heard that the crop was good.

History 1703, pag. 19.

N. B. *This account is the more remarkable as in a description of the like mischief by hail at Hitchin in Hertfordshire, on the 4th of May in the philosophical transactions it is said, "It cut down great fields of " rye as with a scyth, and has destroyed " several hundred acres of wheat, barley, &c. in so much that they plough " it up, and sow it with oates."*

Vid. Lowthorp's abridgement, vol. 2d,
pag. 147.

Mr. Dodart having received from Mr. Lippi, a licentiate of the faculty of physick at Paris, a letter dated from Siout, in the upper Egypt, the 5th of September 1704, and which contained a singular fact, communicated it to the company.

A curious
petrified
bee-hive.

Mr. Lippi found upon the mountains of Siout, at the entrance of a vast cave, a body that was truly stone, of an irregular figure, but intirely porous, which he had the curiosity to open. He was very much surprized to see it all divided into oval cells, of 3 lines in breadth and 4 in length, placed in all directions, with regard to one another, no ways communicating with each other, lined all on the inside with a very delicate membrane; and, what is the most marvellous, containing *each* either a worm, or a maggot, or a fly perfectly resembling a bee. The worms were very hard and solid, and might be considered as petrified; neither the maggots, nor flies were *so*, but only dried and well preserved like ancient mummies. The flies had in many places under them little oval grains, which seemed to be eggs. There was at the bottom of abundance of cells a thick, blackish, and very hardened juice, which appeared red when held up against the light, was very sweet, made the saliva yellow, and burned like rosin. In a word it was true honey.

Mr. Lippi conceived that it was a natural bee-hive, which had been at first formed of an earth loose, light, and sandy, and which had been afterwards petrified by some particular accident. The animals that inhabited it had been surprized by the petrification, and as it were fixed in the state wherein they were found.

found. Their mucilage which became dry had formed the membrane that lined the cells: at the time that the hive was yet soft the worms and the flies went out to get their food, and the flies *there* made their honey.

Looking about in the same place for new lights on this fact, Mr. Lippi found in several places the beginnings of a like hive.

History 1705, pag. 36.

Mr. Maraldi brought from Italy some hard ^{Petrified} stones of a whitish colour, that split into ^{fish.} leaves, in which are found fish dried, straws, and leaves of the olive tree; they were found near Verona by Mr. Bianchi, knight. It happened luckily that in splitting the greatest part of those that contained a petrified fish, they split exactly in half, in so much that the two parts are easily distinguishable. It looks as if they had been imprinted in a kind of mould. All the external parts of the body of the animal are very exactly marked, and there is no room to doubt but that they are real fish, enveloped by a sand that afterwards petrified.

Mr. Maraldi hath seen in the gallery of the Great Duke the like fish dried in stones, that had been taken in Phenicia, in the territory of the town of Biblis, called at present Gibeal, upon mountains almost inaccessible, and 15 miles distant from the sea.

He

He hath seen likewise at Rome several great pieces of marble, mixed with red and white, which were brought from mountains in Sicily. What forms the white is a great quantity of shells included and incorporated into the marble.

History 1703, pag. 22.

Of petrifi-
cation and
origin of
stones.

With regard to the production of stones, we have nothing known with more certainty than the origin of those crystalline congelations, that hang sometimes from the vault of subterraneous grotts, sometimes line the side walls, and sometimes cover the floor. You may almost follow with your eye their growth; at least it is incontestable that it is owing to the little solid parts which a liquid continually deposits. The assemblage of these little parts, deposited one upon another, forms *in time* lumps which are our crystalline stones. We shall make no difficulty of calling by the terms *lapidific juice*, or *stony juice*, that water which is loaded with the matter proper for the formation of this kind of stone and of all others. These terms thus explained cannot be equivocal. It is of no moment whether the matter with which this water is loaded be called *stony matter*, or whether it be called *crystalline matter*, [as Mr. Geoffroy would have it: this last term however appears to me, says Mr. Reaumur, extremely proper, and to give a more precise idea than that

that of *stony matter*. But this matter that forms crystals, what is it? I consider it, says Mr. Reaumur, as an extremely fine sand, which is *so* to such a degree, as to be easily supported in water. Gross art, by pounding emeril, puts it in a condition for remaining several days in common water without sinking to the bottom. Nature may go still further; the sand that the water detaches from hard stones by mere rubbing is probably of an inconceivable fineness: indeed art goes as far, perhaps, as we have need to make nature go in this business, since by mere beating it reduceth gold to swim in water, to be supported in it as if it was dissolved, and to be in a condition to pass with it through refining paper.

The lapidific, or stony juice, forms crystallisations, crystals, and all the transparent stones, when the solid parts that it carries along with it fasten immediately one to another; the same juice forms stones with grains and common stones, when it deposits those solid parts amidst sand and gravel, between mixtures of sand, gravel, and talc, or lastly amidst gravelly earths: it compacts the parts of those different materials so as to make an entire solid mass; from thence come brown free-stones, granates, common stones, and an infinite number of other sorts of stones that are between the preceding sorts. But I conceive that the same juice forms flint stones by petrifying stones a second time, if I may
be

be allowed the expression, or by petrifying the more compact earths; I mean that the stones already formed, but spongy after their first formation, become flints, if they are penetrated anew, and to a certain point, by the stony juice. In like manner clays, chalks, marls, boles, and all the compact earths, being penetrated by the crystalline or stony juice, become flints. I compare the three classes of stones, of which I have been speaking, to three sorts of vitrified substances, or that have begun to vitrify, which art represents to us in common potters ware, china ware, and glass. As these three sorts of substances differ from each other chiefly in their different degrees of vitrification, because they have each more or less of vitrified matter; in like manner the class of stones with grains and common stones, that of flints, and that of crystals, differ in the quantity of crystalline matter that they have received from the stony juice: flints are with respect to the two other classes of stones, what china ware is with respect to glass, and to common potters ware.

But to explain more fully my notion on the origin of flints, let us apply it to an example that may be converted into a proof. I confine myself to a piece of common stone, such as lime stone, or building stone; these stones are naturally spongy, at least they were so before they were drawn out of the womb
of

of the earth; they are easily steeped in water, in their bed they are fully soaked with it; but we must not imagine that it is always the *same* water that lodges there; the water is strained through these stones; what drops continually from vaults, or roofs, of abundance of quarrys is a proof of it. Let us suppose that the water, which enters into these stones, and must pass through them, is loaded with a crystalline matter which is extremely fine. If this water arrives to a certain part of the stone, and there deposits the solid particles it hath brought with it; these little parts will by insensible degrees fill the vacuities that are between the grains of the stone, and at length entirely stop them up. This stone from being spongy, as it was before, will become almost impenetrable by water; the vacuities which were between its little lumps being filled, and those lumps connected to the little stony grains that have formed themselves between them, the stone will become harder, it will no longer have any perceptible grains, and its broken fragments will always have a polish, which is one of the principal characteristics of a flint stone: it will likewise at the same time have acquired transparency, because the matter, which *now* occupies the intervals that were between the former lumps, is of a density more nearly approaching to *that* of the matter of the lumps, than was that matter which occupied *before* the
same

same intervals, *namely*, than air. In a word, this stone will have become a true flint. If it is taken out of the quarry before the water hath deposited a sufficient quantity, it will be found *more* a flint in some places than in others; that place, where the juice first stagnated, and where all the passages have been the soonest stopped up, becomes the ground or foundation of the whole. According as the water shall have had more ease in passing and depositing in certain directions, there will be found veins *more* flintish than the rest, other places will be found where there are only the beginnings of a flint.

To shew that what we have been describing is not a mere imagination; and to give examples of stones, where all seems to have passed as we have mentioned, you need only go along the wall of the new enclosure of the park of Vincennes, which is by the road-side to St. Maur. In this wall, which is more than half a league in length, you will find at each step stones, of which one part is common stone, and the rest flint. I have observed these stones with great attention, am persuaded that I have discerned in several the different states through which they have passed, in order to become flints, and am satisfied of seeing *there* flints of different ages and different degrees of perfection.

But it is not stones alone that may become flints; all the compact earths, such as marls
are,

are, chalks, boles, and very close clays, will be transformed into this sort of stone, as soon as their little clusters shall be penetrated and connected together by the stony juice.

All clay however is not changed into flint as soon as it becomes stone. There is a clay that is not sufficiently compact, whose parts are not close enough one to another: this clay may take in time the consistence of common stone, and afterwards become flint.

I have some round flints that would be taken for pieces of clay, if you observed only their surface; they have *there* precisely the colour of gray clay; and indeed this surface, and their first coat, are, strictly speaking, still earth, they may be diluted with water: beneath this first coat they preserve the colour of clay, but by touching them, and by rubbing them, you are assured that they are stones. Lastly, the more you advance internally the more you find them to be stones, the more you discover in them the essential character of flints, namely, the smooth breaking, and *being* without grains; there is wanting nothing to them but a little transparency.

When clay and the other compact earths are dried, they chap, they split asunder; these chaps, which are in a straight line, cross one another in a thousand irregular manners, and form infinite sorts of figures, that have not any regularity, but are constantly included in straight lines. If you hold up
agates

agates to the light of the sun, to the light of a candle, or to broad day light, you will often discover within them figures resembling those of chapped clay : this is more common in oriental agates than in others. Mr. De la Faye shewed these sorts of figures to the academy in 1716. It always appeared to me that these figures could not be better accounted for than by supposing that the juice, which had hardened these stones, had for its basis chapped clays, and Mr. De la Faye at that time was pleased to adopt my opinion. The chinks formed by those chaps were, like the rest, filled by a crystalline juice ; but the chinks, tho' exactly filled, yet being *so* by more of the crystalline matter, and less of earthy matter, have a transparency different from *that* of other places, and this difference of transparency sufficeth for tracing within agates those figures, of which we have been speaking.

It is to a stony juice, a crystalline juice, to a juice of the same nature as that which forms crystalline congelations, that we have attributed the change of stones and compact earths into flints ; almost all those flints in which are found void cavities, however small they may be, appear to furnish solid proofs of this opinion. Let us observe *these* cavities, you will almost always see crystals in them ; now it is by no means probable that the matter which hath formed these crystals hath penetrated

netrated the flint since it is become a flint. The crystalline juice, the stony juice, is conveyed by a common water, in which it floats; now the substance of flint is scarce penetrable by water; even when it is in its bed, it is always found there with a solidity and hardness approaching to what it hath above ground: it is therefore more probable that the matter, which hath formed the crystals, traversed the flint whilst it was yet only common stone, or compact earth.

When the solid parts of this juice have without any thing intervening caught and fastened one to another, they form in the midst of common stone *transparent stones*, such as they form in the vaults of subterraneous caverns; we may consider each *hollow stone*, whilst it is in its bed, as a little subterraneous grotto.

There are some flints that have only veins of crystalline matter; such are *those* which we find at the top of Champigny, near St. Maur: besides the crystalline veins which are rare in them, they have veins of all sorts of colours, which have so pretty an effect that we cannot forbear mentioning, by the way, that they deserve at least as much to be wrought, as many of those flints which we get from afar.

But some other flints are, as we have said, subterraneous grottos; they contain cavities very considerable with respect to their size;

the sides of these cavities are covered sometimes with white crystals, and sometimes with coloured crystals. Provence furnishes us with some where these crystals are amethysts. Other flints, such as are those of Orel, and St. Die in Dauphiny, contain in the middle of their substance crystals dispersed here and there. But it is to be remarked always that all about those dispersed crystals there are a kind of crevices, sometimes more, and sometimes less considerable, which seem to owe their origin to chaps made in the earth; and indeed these last mentioned flints are of that kind, which we said before have a clay colour, and have still a coat of that sort of earth. It doth not follow however that all the stones, which have cavities where crystals are contained, must be flints; I have some stones from Berry very like to common stones, to the sides of whose cavities are attached very white crystals.

The crystals are formed before the stone begins to be changed into flint; if a stone be taken from the quarry before the crystals have grown *there* as much as they could grow, the stone will not be yet flint, the juice that hath traversed it having been employed in the formation of the crystals.

There are curious persons that preserve flints, on whose broken pieces appear traced some singular figures, such as the bodies of animals,

animals, heads of men, &c. These figures owe their origin only to a particular disposition that happened to be in the arrangement of the cracks; amidst some thousands of broken flints there are a few, where these remarkable arrangements are found, and they are *those* which are collected into cabinets.

Memoirs 1721, pag. 257.

There was wanting to the system of the formation of stones, given by Mr. De Reaumur in 1721, an explication of the roundness affected by certain sorts of stones, and principally by flints; we do not mean a perfect roundness, nor any thing approaching to it, for that is very uncommon, but a general gross roundness. Of the roundness of stones.

The new lights, which we mentioned in 1721 it was better to wait for on this subject, have come and offered *themselves* almost to Mr. De Reaumur.

In a bank of sand, dug near his country house at Charenton, he found a great quantity of little heaps of this same sand distinguished from the rest by being connected, more compact, and almost all irregularly rounded: he calls them knots of sand in imitation of workmen who call knots of clay the like bodies which they find in clay. * These knots of sand were of all sorts of sizes, from that of a pea to that of a man's head, and

E 2

sometimes

* The technical term in French is marrons, chestnuts.

sometimes larger. Several, and particularly the larger, had but one external covering of sand, within which they were stone, and already flint in the center. The general colour of the bank of sand was greenish, it changed in the knots according to the degree of their transformation, it grew brighter and whitened when they were stone, and burnished when they were flint; the stony juice, of which we have spoke, was *here* throughout the whole discoverable. What compleats the proof is, that above this bank of sand there was another of a more gross and dry sand, quite full of flints well formed and perfect, of an infinity of different figures, and all whose figures had their *fellows* in some knot of the lower bank; these knots therefore were destined to become flints.

If the stony juice, whencesoever it comes, or whatsoever course it takes, finds a bank of sand, where it can flow and diffuse itself equally on all sides, and in all directions, it will equally connect all the grains of sand, and make of them a *whole*, which will be one mass or bank of brown free stone; but what will most commonly hinder this exact uniformity, is, that the grains of the sand-bank will not be always regularly enough disposed with respect to one another, a thousand accidents will have made them closer in some places than in others, will have separated them into different heaps, have caused
pretty

pretty large interstices, particularly if the bank is not of pure sand, but mixed with earth, as is common ; the stony juice will *then* have in this bank of sand an unequal course, sometimes more, sometimes less easy : and as this juice, according to Mr. Reaumur, is only a sand, which is prodigiously fine, conveyed in water, that supports it whilst the water hath its whole motion, and doth not let it fall till that motion is checked, it follows that it will not be deposited but in places where the water will meet with some obstacles ; that is, in those places where it will be stopped by the heaps of sand, and by the knots.

The water that is stopped by a knot, of whatever figure it be, divides itself in order to flow round from the most elevated point of that body to the diametrically opposite lowest point ; and this it doth because *this* water being more viscous than any other is on that account more disposed to follow the windings of these bodies ; by this movement it necessarily makes the knot as round as it is possible to be, and flattens the pointed angles of it.

Supposing that we are in the right track with regard to the formation of stones and flints, we may go on to *that* of metals ; analogy will lead us far ; we need only conceive a water loaded with metalline juices, instead of stony juices, and give this water suitable earths that it may pervade : the roundness of

the metalline grains will be explained by the principles already established. But the best grounded hopes ought only to encourage us to make discoveries, and not to make us believe that we have already discovered.

History 1723, pag. 9.

The preceding theory confirmed by an experiment of artificial stone.

Mr. Bafin, a correspondent of the academy at Strasbourg, was willing to try if by following the notions of Mr. De Reaumur he could make an artificial flint.

At the end of the year 1734, he took some potters earth quite prepared for making kitchen earthen ware; the piece was of the bigness of two fists, he steeped it in a good deal of water, and took great care that there should be no gravel in it, or little stone, but only a pulverized earth; he put it into a varnished earthen dish, which he exposed on the outside of a window to the north.

During the course of the two years 1735, and 1736, Mr. Bafin watered this earth almost regularly every day with water from a well, which he judged more proper than any other for his design, because having been filtrated through the ground it must be loaded with more of the stony juice. In 1737, and all 1738, he ceased watering his earth, and in the beginning of 1739, a space of time short enough for such an enquiry, he was willing to see whether any thing had happened.

The

The event shewed that he had not been entirely too impatient. He perceived at the bottom of the vessel an hard body, which he could not separate with his knife as he had the rest, and it was found to be a true stone, as big as an hasel nut, and which he could not break with an hammer, but by employing as much force as would be necessary for beating down the head of a little nail.

History 1739, pag. 1.

The parishes of Meunes and Couffy in the territory of Berry, two leagues distant from St. Aignan, are the places which produce the best flints for a gun in all France, and almost the only good ones; and indeed they not only furnish France, but very often foreign countries; they have been taken from thence without intermission for a long time, perhaps ever since the invention of gun-powder, and yet this district is very small. However flints never fail there, as soon as a quarry is emptied it is shut up, and several years after they find flints there as before.

Observation on flint quarries.

History 1738, pag. 38.

Almost all the modern authors, who have treated hitherto of the natural history of shell fish, have confined themselves to give descriptions and designs of their shells: those cases, if I may be permitted the use of that term, in which are inclosed divers species of

Of the progressive motion of several sorts of shell fish.

sea animals, greatly merited in truth the pains that have been employed, both on account of their singular structure, and for the prodigious variety that there is amongst them; but the animals which they contain were well worthy in their turn of a like attention.

It is true that we have not an equal facility in examining the animals and their shells, the greatest part of which having been collected into the cabinets of the curious could there be pryed into at leisure and without difficulty; whereas whatever is singular in the animals, that they cover, could only be perceived by those who are resolute in putting their patience to long and tedious trials, when their view is to discover the marvels, which nature seems to have taken a pleasure in concealing from us. It is not sufficient to go and search for them on the sea shore, you must sit and watch *there* with diligence for the favourable moments in which they shew us by different actions that they are perfect animals, you must even contrive means to determine them to execute those different actions in *certain* circumstances, wherein you may more easily observe them.

The voyages, says Mr. De Reaumur, which I made some years *since* on the coasts of Poitou and Aunis, gave me convenient opportunities of examining these animals very attentively.

The sea muscles being fastened to stones, or to one another, by several kinds of threads, one would not think that they could have any progressive motion; yet they are able to move, and in order to prove the fact by a single instance, I need only relate the following well known truth.

Of the sea muscles.

At the time the weather becomes too cold to get salt out of the salt pits, the fishermen throw into these pits some muscles which they have taken on the sea shore; they have a notion that the flesh is made more delicate by keeping the animal in a water that is less saltish, for the rain water that falls into these pits, to which they leave at that time no communication with the sea, makes the salt water of the pits more fresh by mixing with it. I shall just mention by the way, that it is by the same means the flesh of oysters is rendered green: the fishermen throw the muscles into these pits separated one from another, and at different distances, and when they go to fish for them afterwards they find them collected into large parcels. Now it is evident that the muscles could not have approached one to another to fasten *thus* without moving themselves, for they are not in a running water. This fact is sufficient therefore to establish their progressive motion.

We must now enquire what part they employ for this purpose: to be satisfied of this you need only open the shell of a muscle on the

Vid. plate
1st, fig. 1st,
L.

the side it naturally opens at; nothing appears in the body of the animal more distinct than a certain black or brown part, the basis of which is placed pretty near the middle of the other parts, and whose point is turned towards the summit of the shell; its length is about 6 or 7 lines. You may form to yourself a pretty exact image of its figure, by conceiving that of the tongue of an animal.

Now this is the part which we may consider as the leg of the muscle, were it not that a shape so different from a leg forbids us to apply the same name to a *thing* that serves however for the same uses, or we may perhaps with more propriety call it the arm of the muscle, since muscles by means of it rather draw themselves along than walk.

It would have been impossible for me to have discovered that this part performs the function I have been attributing to it, if I had observed muscles only on the sea shore; they are never to be seen there but when the sea hath left them on the sand during the ebb of the tide, and at that time they appear always unactive. In order to observe with ease in what manner they make use of this part, I ordered some muscles to be carried to my house as soon as they were taken out of the sea, and I put them in vessels, into which I poured sea water enough to cover them, but not enough to conceal them from
my

my sight; as they were then in some measure in their natural element, they let me see a part of the motions that they use in the sea: this is the general expedient I have employed in order to perceive all that I shall hereafter relate of the other species of shell fish.

I saw that when the muscle is preparing to change its place, it begins with opening a little way its shell: it is of no moment which side it rests on; and a little while after that the shell hath peeped open, you see appear on its edges the point of that part which we have said resembles a tongue; the muscle doth not long confine it there, but gives it soon a greater extent, advancing it beyond the edges of the shell she lengthens it out sometimes to an inch and half from the edges, but often less. When she hath thus changed its figure, by increasing so considerably its length, she makes use of it to feel to the right and left, before and behind, as if in order to examine the ground about her, and to discover on which side it will be most easy for her to advance. All these preparations being finished she seems determined to make her motion, at least you see her bend the extremity of that part which is fleshy, and very flexible, upon some body in order to grasp it; then contracting this same part to pretty near its natural extent, without letting it quit the body on which she hath bent its point, she

Vid. fig.
2d.

Vid. plate
1st, fig. 1st,
L.

the side it naturally opens at; nothing appears in the body of the animal more distinct than a certain black or brown part, the basis of which is placed pretty near the middle of the other parts, and whose point is turned towards the summit of the shell; its length is about 6 or 7 lines. You may form to yourself a pretty exact image of its figure, by conceiving that of the tongue of an animal.

Now this is the part which we may consider as the leg of the muscle, were it not that a shape so different from a leg forbids us to apply the same name to a *thing* that serves however for the same uses, or we may perhaps with more propriety call it the arm of the muscle, since muscles by means of it rather draw themselves along than walk.

It would have been impossible for me to have discovered that this part performs the function I have been attributing to it, if I had observed muscles only on the sea shore; they are never to be seen there but when the sea hath left them on the sand during the ebb of the tide, and at that time they appear always unactive. In order to observe with ease in what manner they make use of this part, I ordered some muscles to be carried to my house as soon as they were taken out of the sea, and I put them in vessels, into which I poured sea water enough to cover them, but not enough to conceal them from
my

my sight; as they were then in some measure in their natural element, they let me see a part of the motions that they use in the sea: this is the general expedient I have employed in order to perceive all that I shall hereafter relate of the other species of shell fish.

I saw that when the muscle is preparing to change its place, it begins with opening a little way its shell: it is of no moment which side it rests on; and a little while after that the shell hath peeped open, you see appear on its edges the point of that part which we have said resembles a tongue; the muscle doth not long confine it there, but ^{Vid. fig. 2d.} gives it soon a greater extent, advancing it beyond the edges of the shell she lengthens it out sometimes to an inch and half from the edges, but often less. When she hath thus changed its figure, by increasing so considerably its length, she makes use of it to feel to the right and left, before and behind, as if in order to examine the ground about her, and to discover on which side it will be most easy for her to advance. All these preparations being finished she seems determined to make her motion, at least you see her bend the extremity of that part which is fleshy, and very flexible, upon some body in order to grasp it; then contracting this same part to pretty near its natural extent, without letting it quit the body on which she hath bent its point, she

she obligeth her shell to advance towards that body.

Thus you see that the contrivance, which muscles make use of in their progressive motion, resembles very much *that* of a man, who lying on his belly would draw near to some place by using only his arm; he would advance his arm to the most distant body that he could seize with his hand, and then shortening the arm would oblige his body to quit its place, as the muscles quit theirs. All the difference there is between the use which the man makes of his arm in the preceding circumstance, and *that* which the muscle makes of this part, is that the muscle truly shortens it, whereas the man would only bend the arm.

Muscles do not often take advantage of the facility they have of moving, for they are commonly all attached one to another, or to other bodies, by divers threads; and it is only when these threads are broken, that it happens to them sometimes to have occasion to make use of that kind of arm. These threads we shall now describe.

From the root of that kind of tongue, or from the place where it is attached to the body of the animal, there issues a great number of threads, which being fixed on neighbouring bodies keep the muscle fastened to them. Each of these threads is pretty near as big as a large hair, or an hog's bristle; they

are

are commonly in length from one inch to two; they come out of the shell on the side where it naturally opens; they are fastened by their extremity on the bodies that surround the muscle, on stones for example, on fragments of shells, and most commonly on the shells of other muscles: these threads are as remote the one from the other, as their length and number will permit; some are on the side of the summit of the shell, others are on the side of the basis, some to the right, and others to the left: I have sometimes counted more than an hundred and fifty employed in fastening one single muscle. These threads are like so many little cables, which drawing each to their side hold as one may say the muscle at anchor. Vid. fig. 3d.

It seemed to me a matter worthy of inquiry, whether these threads were a kind of natural hair to the muscle, which grew with it, and necessarily fastened it, or whether the muscle had a power of fastening itself by means of these threads.

A very plain experiment taught me that in case the muscles were not sufficiently attached from the first, or that their threads were separated from the bodies where they were fastened, they could fasten themselves anew to the like kind of bodies.

After having detached divers muscles one from another, and from the stones to which they were adherent; I shut them up in trunks
that

that were covered, and put them into the sea. I examined these muscles some days after, and found some of them fastened only to the sides of the vessels, others fastened both to their sides, and to the shells of muscles, by the threads we have spoke of before.

This experiment which satisfied a part of my curiosity, increased it at the same time: I wanted to know what contrivance they had for fastening themselves by these threads, how the threads could glue them at their extremity, or whether the extremity, which was much bigger than the rest, might not be considered as a kind of hand, of which the rest of the thread was as it were the arm.

I observed these threads when they were but freshly fastened, and remarked that they were more white, and in some measure more transparent and brilliant than before: this difference gave rise to a notion, and divers other circumstances confirmed it, which was that the threads, with which the muscles had fastened themselves, were not the same threads as I had left them; that nature perhaps had taught some animals of the sea to *spin*, as she has taught *it* to divers animals of the land: in a word that muscles were perhaps in the one element what silk-worms, caterpillars, and spiders, are in the other. This conjecture, bold as it was, did not appear to me to want probability; if it had not enough to persuade me of the truth of so extraordinary

traordinary a fact, yet it had enough to make me try experiments proper to inform me.

The aim of my purposed experiments was to see whether a muscle, stripped of its old threads, would fasten itself in a little time after: for in case it fastened, it must necessarily have spun new threads. But as there would be danger, in tearing off the mass of old threads, that some part necessary for the forming of new might be injured, I made use of the following expedient; after having opened the shell of a muscle a little way, so far as it might be opened without straining the muscular fibres, I introduced a pair of cissars, with which I cut the whole bundle, or tuft of threads. This precaution having been taken, it is evident that I had nothing else to do but to observe whether these muscles thus stripped of their threads would attach themselves as soon as *those* to whom I had left them, and at as great distances; this I saw with pleasure happen some hours after; there were about as many of the muscles that I had treated in this manner, which fastened to the vessels, as there were of those from whom I had not taken a thread; nor did the one attach themselves at a greater distance than the other; I could no longer doubt therefore but the sea had spinsters in muscles, as the land has in caterpillers and spiders.

The part which serves for so singular an use well deserves some attention; we have

hitherto only considered it under the gross image of a tongue; we must at present examine it more closely; we have shewn before that it is the leg or arm of the muscle, which it makes use of, when unfastened from its hold by some accident, in order to move: but we are no longer to consider it as an arm or a leg; it rarely performs their functions; we must consider it now as a wire-drawing instrument.

To make it the better understood we shall observe first, that though in the greatest part of its extent it is flat like a tongue, yet towards its origin, or root, it is round like a cylinder, and that it has there less diameter than elsewhere. Its other extremity, or its point, is made pretty much like the point of a tongue. From its origin, quite to near its point, you see a seam or rather a slit that penetrates pretty far into the substance of this part, and divides it length-ways into two equal parts. This slit is a real duct, and it is in this duct that the liquor passes which forms the threads. Externally it appears only a seam or little slit, because the two superior edges of this duct are a kind of lips, applied one against the other: you see easily that it is hollow, that it hath some depth, and though commonly closed, the muscle hath a power to open it; we shall mention presently in what circumstances she doth it. Fibres pretty nearly circular are disposed obliquely across the

Vid. fig.
4th, A.

Vid. fig.
4th, F. I.

the duct throughout its whole length, they serve without doubt for opening it. The duct doth not reach quite to the point of what we have called before the wire-drawing part; where the duct ceaseth the transverse fibres cease also, and the part hath less thickness; but it reaches quite to the basis of the part at the place where it takes a cylindrical figure. This cylinder is an hollow tube, into which the duct opens; and this hollow tube is probably the reservoir in which is collected the liquor that forms afterwards the threads: it is surrounded by divers glandulous parts, proper for straining a gluish liquor. The muscle like the greatest part of the sea animals abounds with this sort of matter; if you apply a finger on what I call the wire-drawing part, and particularly on its basis, and then draw it away gently, you will draw out divers viscous filaments, such as are drawn from spiders, silk-worms, and caterpillers.

We shall now with ease explain the several motions of the muscle which we observed when she fastened herself, and may conceive those she conceals from our sight: she begins probably with compressing the glandulous parts, which contain the gluish juice proper for forming threads. This juice being squeezed out of the parts, that contained it, discharges itself into the reservoir that is at the basis; from thence the muscle forces some into the duct that runs along the whole length

VII. fig.
5th, K.

length of the part ; the duct being then closed will not permit any effusion. It is without doubt in order to convey it thither that the muscle alternately stretches out, and draws back, its wire-drawing part a great number of times.

The liquor being conveyed quite to the end of the duct, forms a viscous thread; the muscle then applies the tip of its wire-drawer to the body she has chosen, she leaves it there some time at rest, and during that time the viscous thread acquires a consistence, and fastens by its extremity : there remains now only for the muscle to make the thread run out easy from the wire-drawer ; and this she does by means of the circular fibres we spoke of, which serve to open the duct through its whole length ; the duct being opened, the muscle has nothing to do but to remove her wire-drawer from the thread. This you see her do with great quickness ; she draws back the wire-drawing part almost parallel to the new formed thread, and returns it into her shell.

In order to observe all the contrivances, that I have been mentioning, I have often put muscles into glasses full of sea water ; the transparency of the glass and water let me perceive the slightest motions. By this means likewise I have seen that the viscous matter, of which they form their threads, takes hold of the most polished bodies ; for those threads,
that

that they fastened upon glass, held *there* as strongly as what they fastened upon wood or stones.

It sometimes happens that the muscle strengthens her first threads by additional threads, attached to the neighbouring bodies. Whether it be that those threads have been roped too weak, and have broke when she would have given them play from her wire-drawing part; or whether the liquor was not in a sufficiently continued stream through the length of the duct; whatever be the reason, it appears that she is well acquainted that her work may fail in that part; for as soon as she hath roped a thread, and brought back her wire drawing part into her shell, she draws herself upon this new thread, advancing forward as she draws, as if she had a mind to try if it was good and well fastened.

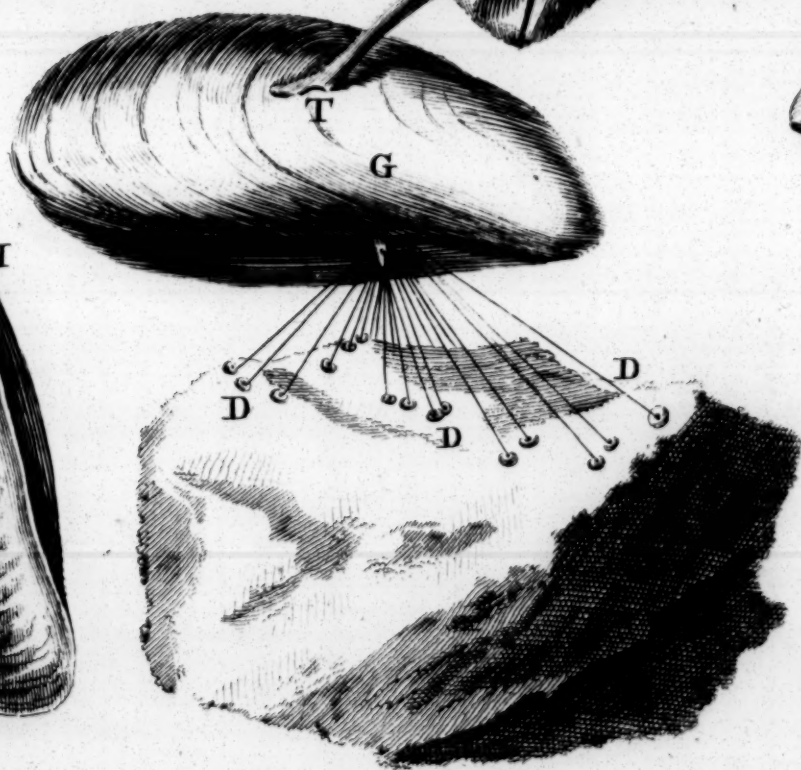
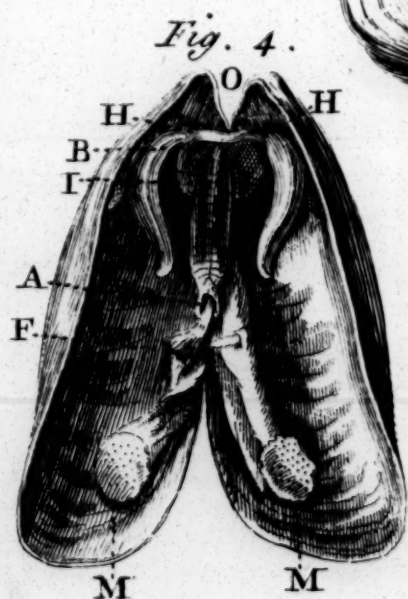
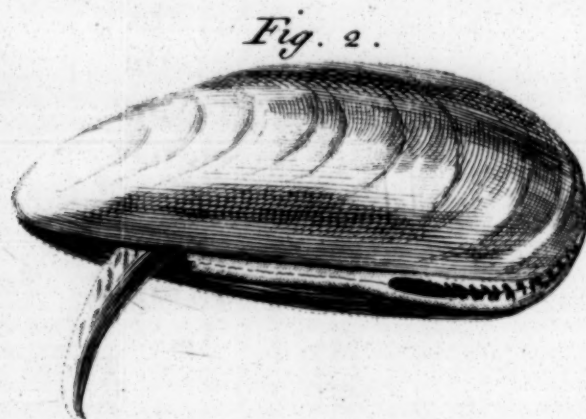
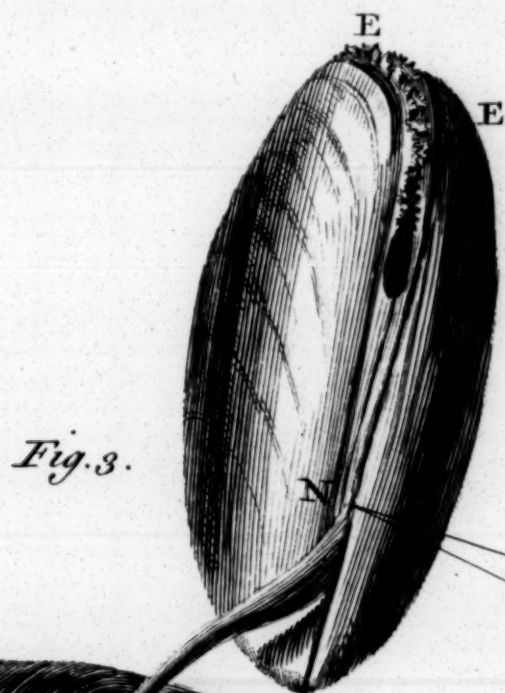
The threads that they have roped, when brought home to my house, have been commonly more fine, and always more white than the old; the colour probably was owing to their freshness; and that they were more fine may be owing in some measure to their having been formed in haste, and at a time when the muscles had not an abundant provision of viscus matter; at least it seems to me very certain that this liquor is easily exhausted. I never saw a muscle that made more than 4 or 5 threads in a day.

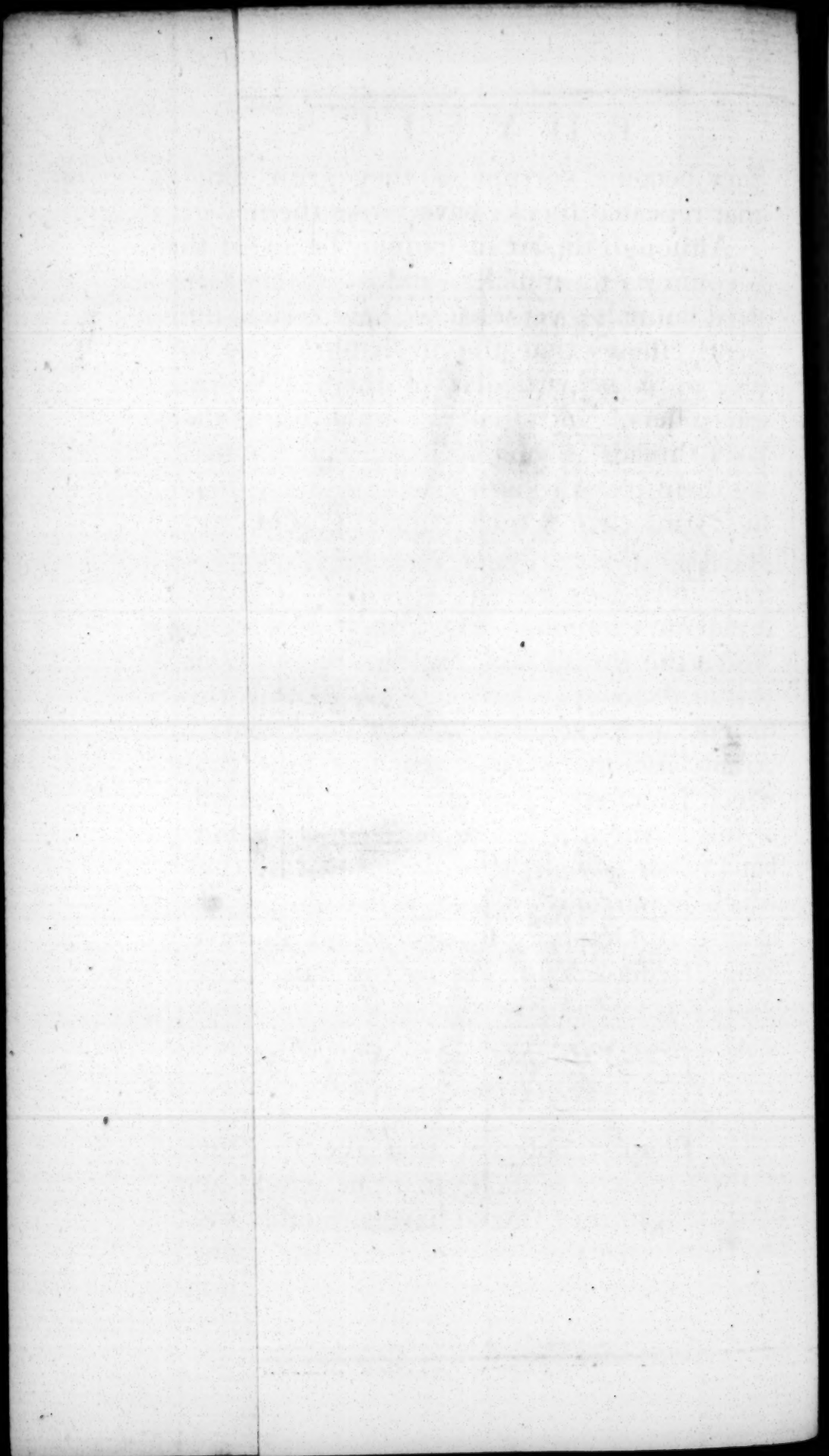
I never could discover whether they could break *at pleasure* the cords that they have formed for themselves: I know that there are many found *detached*, which have large bundles of threads; but divers accidents might have occasioned *this*, without any contrivance of the muscles; and the following experiment seems to prove that they have not the power of unfastening themselves.

After having let some muscles fasten to the sides of a vessel, full of sea water, I drew off the water in such a manner that some were entirely deprived of it, and that others but just touched the water with the edge of their shell. They were then in a violent situation; if there had been any art in them of unfastening themselves, this was the time for making use of it, in order to get into the fluid so necessary for them; yet I perceived no one attempt to break the threads that held him.

Moreover how young soever they may be they are able to spin: I have often times observed some that were smaller than grains of millet, which formed threads, very short indeed, and of a fineness equal to that of the silk worms. And indeed the smallest are collected in parcels as well as the largest. In proportion as they grow they have need of stronger threads to hold them; the old which are become too slender will break of themselves; and very often the old are broken even though they are big, whether it be that
they

f
l
f
n
t
y





they become corrupt as they grow old, or that repeated shocks have broke them.

Although the art of spinning be an art that is common to muscles, and to divers terrestrial animals; yet what we have related sufficiently shews that the mechanism they employ in it is particular to them. Worms, caterpillars, and spiders, draw from their body threads as long as they please, by making them pass through a wire-drawing hole; their process resembles that of gold wire-drawers: the *process* of muscles on the contrary resembles *that* of workmen, who cast metals in a mould. Their duct is a mould where the thread takes its figure, and a determined length: perhaps too like worms, spiders, and caterpillars, they work only in certain months of the year: at least those which I inclosed in vessels during the months of July, August, and September, have spun; but I never saw any threads formed by those which I put into the like vessels during the month of October; I have found however some that have spun during this last month in the sea.

*Memoirs 1710, pag. 439, and Memoirs
1711, pag. 115.*

Mr. Poupart observes that the structure ^{Of river} of these muscles is such, that one would not ^{muscles.} have thought they should have any other motion than what they receive from the agitation

tion of the water; yet they all move, and some even bound and vault upon the surface of the water. The manner of their moving is thus :

Lying on the flat side of their shells, they advance out a part in shape of a tongue, with which they make little motions to the right and left, in order to hollow the sand or clay of the rivers. By making it hollow *thus*, they incline by degrees side-ways, and get upon the edge of their shells, the back being uppermost; they advance forth afterwards by little and little their head for a minute or two, and then rest it in order to draw their shells to them, in the same manner as water snails sometimes do. They repeat this motion as long as they have a mind to move, and in this manner they make irregular tracks, which are sometimes three or four ells long, and in which they are half hid.

You see in the summer time several of these tracks in the rivers, where there are many muscles, and you never fail to find a muscle at the end of each track.

These hollow ruts serve as a support to the muscles, to keep them up on the cutting part of their shell; and in digging the earth *this* way, and *that*, they catch probably some fry of fish, or other little food on which they live.

In consequence of moving they might meet and engender together. I have never found
any

any spawn in muscles; but in the summer you may find a great deal of milk, and of slimy matter, in the same muscle; this makes me conjecture that they may be both sexes in one.

The large gland of the tufted muscle is quite full of a very white milk in the month of September. I think it well worth observing with regard to this milk that it curdles as soon as it is thrown into the water. This coagulation makes me conjecture that muscles do not throw their milk into the water, for it would become useless for generation; I should rather think that a muscle insinuates its milk into another muscle at the time of copulation: the same thing is probable with regard to other fish, and that they do not throw their milk into the water as is commonly believed.

Aristotle says that he had been told there is a large sort of shell fish that leaps and vaults. I have before hinted that this philosopher was not deceived, for I have seen by chance the large sort of pond muscle bound on the surface of the water; this leaping is effected in the following manner. These large sorts of muscles have shells that are very light, extremely thin, and so broad that they can beat with them the surface of the water, as birds *do* the air with their wings. There is at the back of these shells, a large elastic ligament, in the manner of an hinge, and two thick

F 4 muscular

muscular parts within that close them : this is sufficient for leaping, for all that is requisite for that purpose is that these springs act suddenly one after another, and that the fish strike the water with sufficient force and quickness. What farther favours this motion is, that the articulation called ginglymus, which is in the shells of those that do not leap, is not to be found in these ; it would be embarrassing.

Memoirs 1706, pag. 56.

Of the lavignon.

The shell fish to which the name of lavignon hath been given, on the coasts of Poitou and Aunis, is undoubtedly a species of the chamæ, since it hath the character essential to that kind, which is being bivalvular, and always remaining a little open. They have likewise *this* in common with the species that Rondelet speaks of, that their shell is thin and very brittle, insomuch that you may easily break it between two fingers ; and they live like the chamæ in the mud ; but they differ at the same time from those species, that Gesner says are called *flames* in French, and in Italian *peppered*, because they produce on the tongue the same effect as pepper ; whereas the taste of the lavignon is very insipid. Their shell is very smooth and white, particularly on the inside ; for oftentime the oldest part of the external surface of this shell, that is to say, the parts near its summit, have

a blackish colour, which they have taken from the black mud in which the lavignons chiefly live; they keep themselves buried in this mud sometimes more than five or six inches deep. On whatever side you place the lavignon, provided you do not let it rest directly on the summit of its shell, it will easily force its way under the mud: this it effects by putting forth a part which resembles a leg; it hath a power of lengthening out this part, and making it pointed, in order to open its way the better through the mud. The manner it riseth back out of the mud cannot be discerned, but it is probably effected by a contrary use of the same part; I mean, that it puts out from the edges of the shell the extremity of this part, bends it back and flattens it as much as it can, in order to sweep away the mud that is above. What facilitates its motion both downwards and upwards is, that its shell is made somewhat like a wedge. The lavignon can glide likewise upon the mud, by pushing out its leg against the mud, and forcing the shell forwards, as a man in a boat pushes himself on with a pole. Mr. De Reaumur observes however, that it cannot sink under the mud further than the length of the two horns or tubes, Vid. plate 2d, fig. 1st, CC. that it can put out of its shell, will permit. With these horns it takes in and throws back water, which must therefore always have a communication with the water that is above: it

it is from thence that there are in the mud, which covers the lavignon, one or two little holes of the diameter of his horns, which serve to discover him.

The length of these horns, in other shell fish which have them, determines likewise the depth they sink to in the mud.

Of the
star-fish.
Vid. plate
2d, fig. 2d.

The star fish, although it hath 304 legs to each of the five *radii* that compose it, *which* have occasioned the name of star to be given it, gains no swiftness from them; its 1520 legs give it no advantage over the muscle that hath but one. What an amazing variety in the works of nature! To speak properly these legs are but a kind of horns, like the horns of our garden snails, which it lengthens and contracts at pleasure. By extending a part only of *those* of each radius, and fastening them successively on some solid body, they draw themselves along. In order to convey an idea of the manner in which they extend their legs, it is necessary to lay open the internal parts of one of the radii. On cutting the hard skin of the upper surface, or the surface opposite to *that* where the legs are situated, the internal part of the star-fish appears divided by a kind of cartilaginous body: this body seems composed of a great number of *vertebræ*, disposed in such manner that you find a groove in the middle, which they form by their assemblage: on each side of this groove you see two rows of elliptical

elliptical spheroids or oval bladders, extremely transparent, somewhat more than a line long, but less in bigness. They look like strings of pearls. These little bladders are formed of a thin membrane, but very strong, and the inside is full of a water. It is not difficult to discover that these bladders are subservient to the extension of the legs; one begins to suspect it as soon as one observes that the number of bladders is equal to *that* of the legs, and that each bladder corresponds to a leg: but the whole ingenious mechanism displays itself by pressing with a finger some of these bladders; you then see them empty themselves, and at the same time perceive the corresponding legs to swell. Lastly, after having ceased to press them, you see them *fill again*, whilst the legs *subside* and *shorten*. It is evident that the star-fish need only to press the bladders, in order to make the legs swell, in the same manner as they are pressed by the finger; and it is easy to imagine a thousand ways by which they may effect *this*. The bladders being pressed discharge their water into the legs, which swell and extend themselves immediately; but as soon as the star-fish ceases to compress the bladders, the natural resili-
tion of the parts causes the legs to sink, shortens them, and drives back the water into the bladders, from whence it was derived.

A viscous matter serves to fasten the star-fish when they have a mind to fix themselves. This viscous matter is conveyed to the extremities of those numerous legs; and when a leg is glued against a stone, it is easier to break it than to detach it from thence.

Vid. plate
2d, fig. 3d
and 4th.

M. De Reaumur hath observed a species of star-fish which hath five radii like that we have been speaking of, but which hath no legs to these radii, and which differs besides from the other in *this*, that the radii have the shape of the tails of lizards. The five radii are *themselves* the legs; the animal fastens two of them on the place whither it would advance, in the form of *books*, and drags itself along on those two, whilst the radius, that is opposite to them, bends itself in a contrary direction, and, thrusting against the sand, pushes forward the body of the star towards the same place. There are two others that continue unactive, but they would no longer be *so* if the animal wanted to turn to the right or left; and we see how by this means it can move on all sides with equal ease, never employing more than three legs or radii at a time. Perhaps likewise nature hath given it five legs, because, according to Mr. Reaumur's observation, they are easily broken, and it is proper the animal should have a reserve.

Mr. De Reaumur hath since discovered that the star-fish, like the polypus,

Per

*Per damna, per cædes, ab ipso
Ducit opes animumq; ferro.*

Vid. Mr. Reaumur's preface to his sixth
vol. of the history of insects, pag. 61.

The sea-urchin, or hedge-hog, takes its name from the thorns or prickles with which it is covered. There are several different species of this fish.

Of the
sea-
urchins.

Naturalists have with reason believed that the sea-urchins make use of their prickles as legs. I have seen them walk with these prickles in circumstances where it was not possible for me to be mistaken. Not only have I seen them move themselves by their means, when I have put them in vessels where sea water covered them a little, and by consequence where it was easy to observe them; but having put the same animals even upon my hand, I have seen them execute their progressive motion with their prickles alone. This fact is therefore certain, however contrary it may be to the observations of Mr. Gandolphe. Besides these prickles, which are truly legs, they have likewise what resembles the horns of snails; so that we shall give them the name of horns. Their use is far different from that which Mr. Gandolphe hath attributed to them; instead of serving for the motion of sea-urchins, they serve to fasten them. The sea-urchin employs them likewise, whilst he is in motion,

Vid. plate
2d, fig. 5.

in

A viscous matter serves to fasten the star-fish when they have a mind to fix themselves. This viscous matter is conveyed to the extremities of those numerous legs; and when a leg is glued against a stone, it is easier to break it than to detach it from thence.

Vid. plate
2d, fig. 3d
and 4th.

M. De Reaumur hath observed a species of star-fish which hath five radii like that we have been speaking of, but which hath no legs to these radii, and which differs besides from the other in *this*, that the radii have the shape of the tails of lizards. The five radii are *themselves* the legs; the animal fastens two of them on the place whither it would advance, in the form of *books*, and drags itself along on those two, whilst the radius, that is opposite to them, bends itself in a contrary direction, and, thrusting against the sand, pushes forward the body of the star towards the same place. There are two others that continue unactive, but they would no longer be *so* if the animal wanted to turn to the right or left; and we see how by this means it can move on all sides with equal ease, never employing more than three legs or radii at a time. Perhaps likewise nature hath given it five legs, because, according to Mr. Reaumur's observation, they are easily broken, and it is proper the animal should have a reserve.

Mr. De Reaumur hath since discovered that the star-fish, like the polypus,

Per

*Per damna, per cædes, ab ipso
Ducit opes animumq; ferro.*

Vid. Mr. Reaumur's preface to his sixth
vol. of the history of insects, pag. 61.

The sea-urchin, or hedge-hog, takes its name from the thorns or prickles with which it is covered. There are several different species of this fish. Of the
sea-
urchins.

Naturalists have with reason believed that the sea-urchins make use of their prickles as legs. I have seen them walk with these prickles in circumstances where it was not possible for me to be mistaken. Not only have I seen them move themselves by their means, when I have put them in vessels where sea water covered them a little, and by consequence where it was easy to observe them; but having put the same animals even upon my hand, I have seen them execute their progressive motion with their prickles alone. This fact is therefore certain, however contrary it may be to the observations of Mr. Gandolphe. Besides these prickles, which are truly legs, they have likewise what resembles the horns of snails; so that we shall give them the name of horns. Their use is far different from that which Mr. Gandolphe hath attributed to them; instead of serving for the motion of sea-urchins, they serve to fasten them. The sea-urchin employs them likewise, whilst he is in motion, Vid. plate
2d, fig. 5.
in

in order to discover or feel the ground about him, as snails make use of theirs, or as a blind man feels with a stick the bodies that are in his way.

For this reason the sea-urchin lengthens out, and shortens, alternately these horns during his march ; but the number of them is much greater than Mr. Gandolphe imagined. The urchin hath them not only about the mouth, as Mr. Gandolphe observed, but amidst all the prickles, particularly on the upper surface of his body.

The provision, with which so little an animal is furnished, is something marvellous : It hath 1300 horns, which serve for keeping it at rest ; and this is done by applying their extremities to some body, and gluing them to it, as we mentioned of the star-fish, so strongly, that if you would employ a force sufficient to unfasten them, you would rarely effect it without breaking a part of those that held the animal ; and it hath more than 2100 prickles, which it may make use of for moving. Those which it makes use of the most commonly are about its mouth ; as they can incline equally on all sides, it can likewise advance every way with equal ease. The prickles which are the nearest, and those which are the most remote from the place whither it is determined to move, are subservient to it at the same time ; it draws itself on with the first, and pushes itself forwards

ut
2
at
ns
u-
is
d.
be
ut
ne
ri-
s:
p-
ng
ng
h,
ce
ly
at
an
or
ne
ey
e-
e.
d
ne
re
ws
r-
ds

Fig. 1.

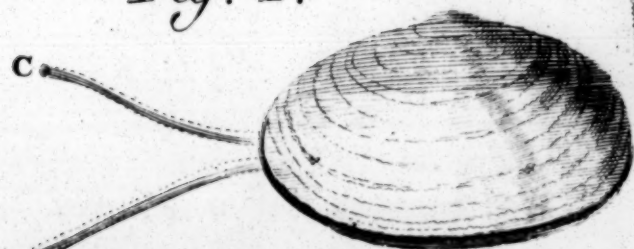


Fig. 2.

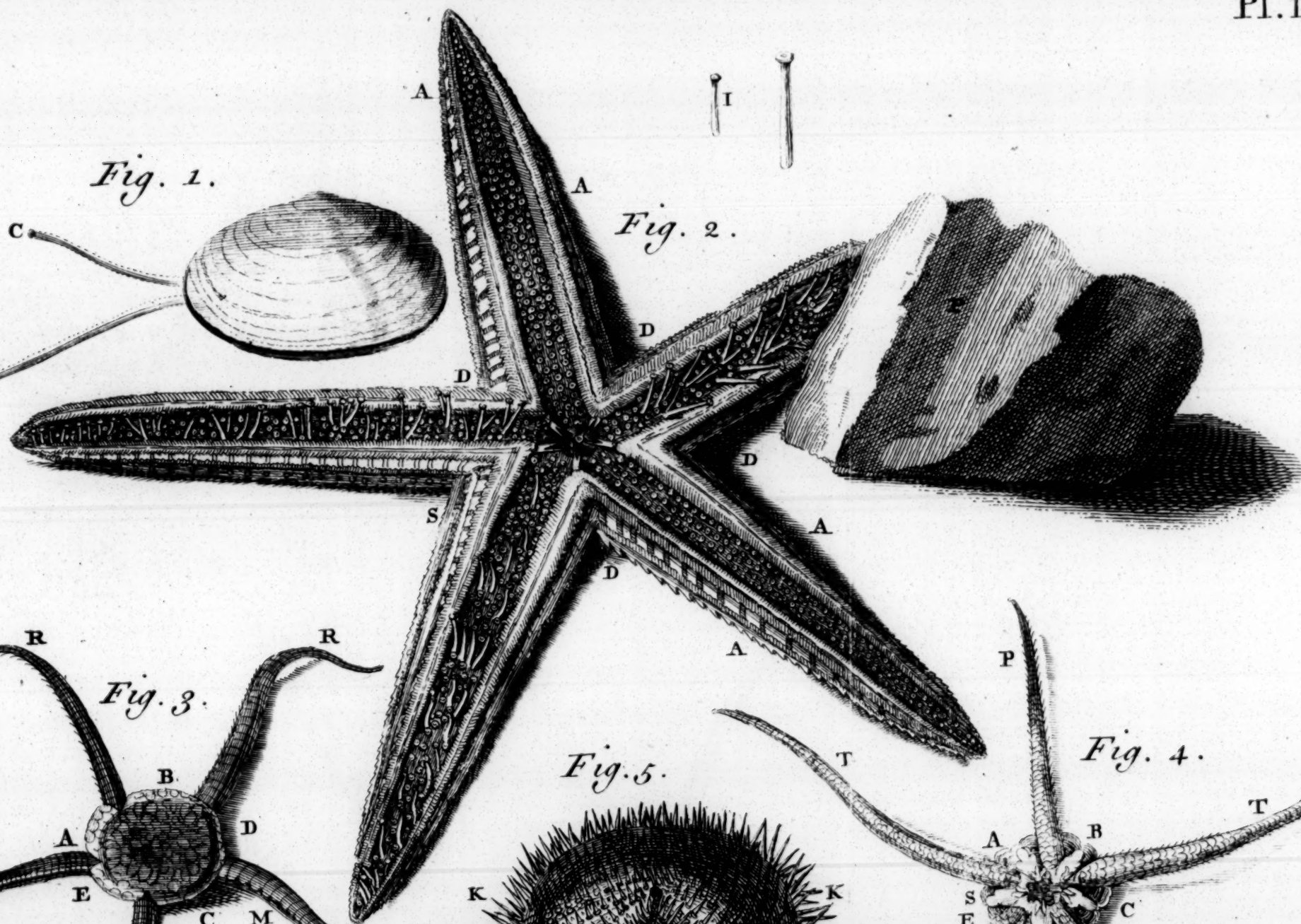


Fig. 3.

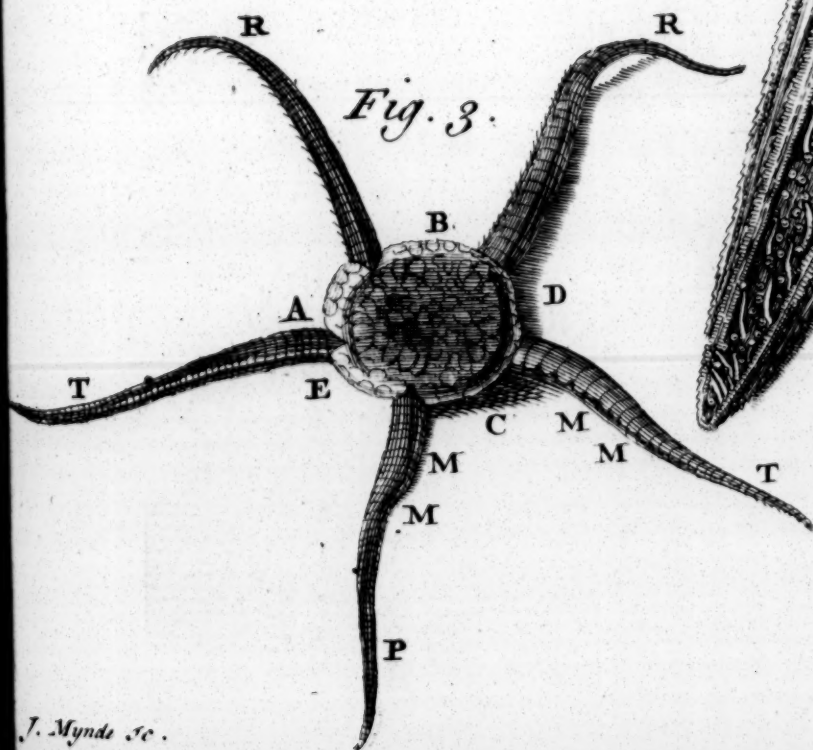


Fig. 5.

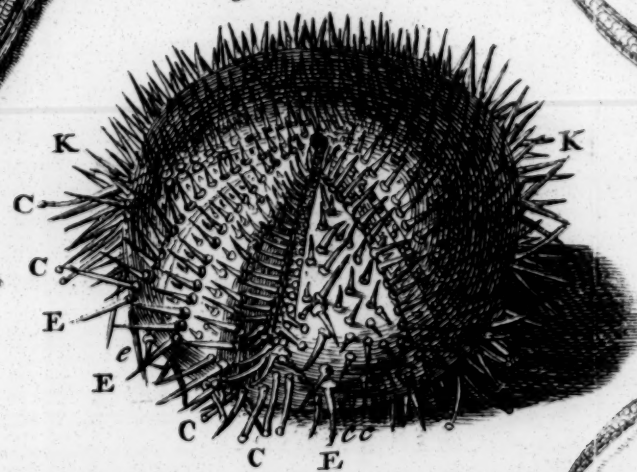
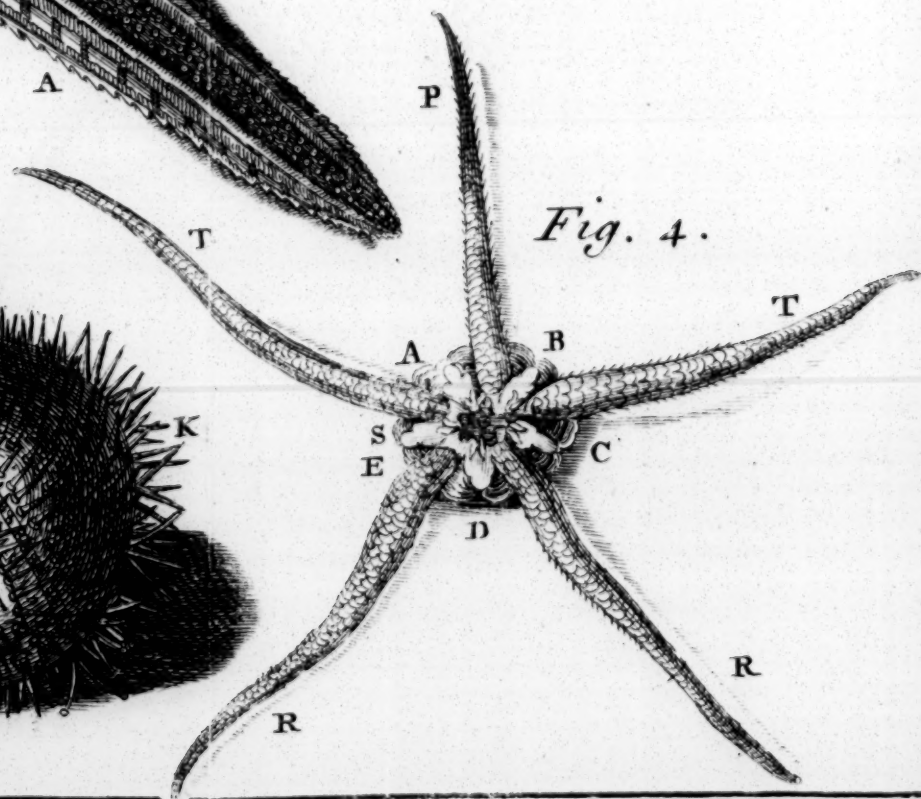


Fig. 4.



THEY ARE

side with the water. How many months
is required to put in motion, to the
and separately, a good way and good
All the water in the world is

of the two kinds, but
the water in the world is
the water in the world is

the water in the world is
the water in the world is
the water in the world is

the water in the world is
the water in the world is
the water in the world is

the water in the world is
the water in the world is
the water in the world is

the water in the world is
the water in the world is
the water in the world is

the water in the world is
the water in the world is
the water in the world is

the water in the world is
the water in the world is
the water in the world is

wards with the latter. How many muscles are requisite to put in motion, on all sides and separately, 2100 legs and 1300 horns!

All the *sorts* of urticæ have been distributed into two kinds by Aristotle in his history of animals, lib. 5. chap. 16. of which one comprehends *those* that remain their whole life fixed in the *same* place like plants; and the other, on the contrary, contains all the sorts of urticæ that change their place, and love the shores and level places.

Of the
urticæ
marinæ, or
sea nettles.

My own observations give me reason to doubt of the exactness of this distribution by Aristotle, since I have not been able to find any sort of urticæ, even among those that keep in the holes of stones, but what were capable of some progressive motion. Indeed the greatest part of *those* we find fastened upon stones move themselves so slowly, that, respecting *appearances*, there is great reason for thinking *them* unmoveable; and I should have taken them undoubtedly as *such*, if I had examined them only on the sea-shore, their progressive motion being as slow as *that* of the hand of a clock, for they scarce move an inch or two in an hour.

I know not whether there is any better foundation for giving them the name of urticæ, or nettles, because it is pretended that they cause, like that plant, a burning itching in the parts that have touched them; for all the sorts of urticæ, which come upon
the

the coasts of Poictou and Aunis, produce not any such effect.

Pliny, although he allows them the sense of feeling *equidem & his inesse sensum arbitror*, yet he cannot prevail with himself to rank them amongst animals, but makes them, after Aristotle, of a middle nature between plants and animals, *quæ neque animalium, neque fruticum, sed tertiam quendam ex utroque naturam habent*; he doth not however espouse the reasons assigned by Aristotle; for one of the greatest resemblances, that Aristotle found between the *urticæ marinæ* and plants, was that the *urticæ* did not appear to him to have any passage for the discharge of excrements, whereas Pliny says that they discharge their excrement by a fine tube, *excrementa per summa tenui fistulâ reddi*. This tube may well be supposed to be one of the horns of the *urtica*; but what these horns throw forth hath not at all the appearance of excrement, since it is a very clear water.

Be that as it will; if we keep to common notions, we must consider the *urticæ marinæ* as real animals; for how can we refuse the name of animals to bodies so well organised, that give not only marks of sensation when they are touched, but which catch fish, and particularly shell-fish, and eat them: lastly, which have a progressive motion, as Aristotle and Pliny have acknowledged with regard to several sorts?

The urticae take successively so many, and such different figures, that it is scarce possible to describe them under any determinate figure; it may be said in general, however, that the external figure of the body of the urtica approaches pretty near to *that* of a truncated cone, the basis of which is applied to stones, to which we find it always adherent; but the basis of this cone, which appears often circular, is sometimes elliptical, sometimes of an irregular figure; sometimes the cone is perpendicular to its basis, sometimes oblique; its height varies in proportion as the basis is enlarged or diminished; I mean, that when the basis becomes greater, the height becomes less, and that it is more lofty as the basis is more confined.

The upper surface of the urtica, or that which is opposite to the basis, is not so flat as should be in a truncated cone, it is commonly convex. In the middle of this surface is an opening sometimes bigger and sometimes smaller, according as it pleases the urtica to increase or diminish it.

In order to form in the imagination a pretty exact idea of the urtica, you may consider it under the shape of one of those purses wherein counters for cards are kept, with this difference however, that its opening, which resembles that of the purse, closes itself without the rest of the outside covering of the urtica being puckered from top to

bottom, as those purses are to which we have compared it.

When the urtica enlarges greatly this opening, almost all its horns appear; they are in figure like the horns of snails, but their function resembles more perhaps *those* we have mentioned of certain shell-fish, since it often happens that the urtica throws out very fine spouts of water at their extremities, when you touch it.

If the urtica, not content with enlarging greatly its opening, turns back likewise the circumference of this purse, in the manner one turns back a stocking, so as to expose externally a part of its internal surface, you *then* see all its horns displayed; which makes a very singular appearance, and doth not ill represent a flower in blossom.

The variety in the colour of urticæ of different species; or of the same species, equals almost the variety of the figures, that the urtica assumes successively; some are greenish, others whitish, others of a rose colour, and some others of different sorts of brown. In some urticæ these colours appear throughout the whole surface, in others they are intermixed with streaks, or spots; sometimes these spots are distributed regularly, sometimes irregularly, but always in a very agreeable manner.

Vid. plate
3d, fig. 1st.

Some urticæ have a flesh harder than *that* of others; but the most considerable difference

rence is that the external surface of the flesh in *some* is shagreened ; it is scarce necessary to mention that the external flesh is not covered by a shell, or by any substance like it.

The purse is the cover or case, in which all the parts of the urtica are contained ; but in such manner that they never fill intirely the case, unless the urtica hath closed its opening. All this purse, that contains the urtica, is a part truly muscular, consisting of straight and circular muscles, to which I shall give the name of tubes ; because you often find them filled with a watery liquor, that runs out upon piercing a tube. Indeed these tubes are not visible, but when they are distended by water ; and it depends on the urtica, to make which it will of these tubes perceivable, by swelling the one or the other throughout their whole extent, or in a part only, as itself pleases : their whole progressive motion consists in general in *this*, that all the muscles both the circular and the straight, that are of that side to which the animal would move, swell, and extend themselves, and by consequence occupy a little part of some new place, whilst the muscles of the opposite side continue flaccid, and are drawn on by that part which advances ; this motion however is as slow, and as little perceivable as the hand of a clock.

It is by means of the swelling, and subsid-
ing of these muscles, both straight and cir-
G 2 cular,

cular, that the urticæ change their external figure in so many ways.

I have seen *some* urticæ make use of *their* horns for moving themselves; these urticæ were of *those* sorts that live in the holes of stones; but when they trailed themselves by means of their horns, their position was inverted; that is to say, their basis was uppermost, and their horns downwards. These sorts of urticæ have their horns extremely gluish, and even rough to the touch, so that they can easily draw themselves on by their means.

It is very surprising that an animal so soft in its texture as this is, that hath no foot, or any thing equivalent to it, can devour animals so well defended by their shells, as muscles and other bivalvular shell-fish are. It is certain however, that the urticæ feed on the flesh of these animals; but it is not easy to discover by what artifice they draw them out from their shells; all that can be discerned is, that they introduce those shell-fish quite intire through their mouth, or rather opening.

After having thus introduced the shell-fish intire into their body through this opening, they contract it in such manner that there is no external appearance of so large a body being contained within their *own*: it is *then* that they suck those shell-fish at their ease; but the manner of their sucking, as it is

is transacted internally, cannot be discovered; after having sucked out the fish, they discharge the empty shells through the same opening as they had introduced them.

For the expulsion of the shells, the urtica not only enlarges greatly the opening, but turns back the edges of it, as one turns back a stocking. The same turning of the inside outwards, both of the purse, or external covering, and of the mouth of the animal, serves likewise for the delivery of their young, for the urticæ are viviparous and bring forth sometimes a dozen at a birth, but always one after another, although the opening they make is wide enough for letting pass several at a time.

But the most remarkable thing of all in the urticæ is, what Mr. De Reaumur hath *since* mentioned in his history of insects, that several of these conical animals having been divided in two by a section along the axis, the two halves that were separated became by degrees complete cones, and each formed a perfect urtica. Vid. preface to the sixth volume of the history of insects, pag. 62.

There is another sort of *urtica marina*, or sea nettle, that fastens itself to nothing, and from thence is called the *wandering* urtica; it hath a vast variety of names on the different coasts of the kingdom; I should be inclined to call it the *sea gelly*, a name that characterises very properly the substance of which it is

composed; for it dissolves away in the hand. It could not be ranked in the number of animals, but that one observes in it a motion of systole and diastole, the only sign of life which it gives.

Of the le-
pas or lim-
pet.

We have several times mentioned that the shell-fish fasten themselves to stones, and other bodies, by means of a glue. If immediately after you have detached a lepas or limpet, you apply a finger on its basis, or on the part of the stone which it touched; when you would draw away your finger you find it held by a glue that was imperceptible to your sight.

Now it is to be remarked that if the water hath ever so little wetted the stone, or the basis of the animal, the glue then will have no hold on the finger that touches it: likewise when in taking off the lepas you have made a considerable wound at its basis, the glue is *then* no longer sensible to the touch; the wound lets out the water which hinders its effect.

From hence I think we may conjecture the method that nature hath taught this shell-fish, in order to break the bonds which are often necessary for its defence against the agitation of the waves, but which would cause it to perish if they withheld it at the time it ought to go and seek its nourishment.

To conceive the manner by which it fastens and unfastens itself, you must consider the

the basis of the animal as full of an infinite number of little grains like shagreen, a part of these grains are little cells filled with water; of this there can be no doubt, since they let the water run out as soon as they are opened by a wound at the basis, how slight soever the wound may be. Another part of these grains contains the glue we are speaking of, or if you will there may be some other vessels that convey the glue throughout the whole basis.

If the animal wants to fasten itself, it squeezes out the glue from the vessels that contained it, and presses its basis thus moistened against some stone that the sea hath left bare during the ebb. If it would quit the same stone, it need only to press those cells that contain the water; the water runs out, dilutes the glue, and the animal is at liberty to go and seek its food.

Moreover the animal hath not the liberty of attaching itself so often as it might be willing; it hath not a sufficient stock of glue for that purpose.

Having detached two or three times successively in a small compass of time several lepadæ, they could no longer fasten, or fastened themselves very weakly, their source being exhausted; they wanted time to repair the waste that had been made.

Borelli hath placed the lepadæ amongst those fish that continue their whole life fixed to

the same spot ; but Aristotle hath taken care to remark that it doth detach itself from the stones in order to seek its food. I have never seen it on the sea shore have any other motion than that of lifting up its shell, a line, or a line and half from the stone, to which its basis is applied, and making it fall back again with great quickness as soon as it was touched.

But those which I have kept alive at home have shewn me that they have a progressive motion, and the manner in which they execute it ; it is by means of a large fleshy part, that is in the center of the shell, and makes the basis of the animal ; its substance is much more solid than that of the other parts, and its size is equal to *that* of all the other parts taken together. And it is a remark I have made on all the shell-fish I have hitherto seen, that the part, which they employ for their progressive motions, hath almost as much flesh *alone* as all the rest of the body of the animal.

The *lepas* makes use of this part to move as our land snails employ a kind of foot for the same use ; and indeed their slowness of motion is pretty much alike.

History and Memoirs 1710, 1711, 1712.

Of the razor, cutler or sheath-fish.

It is certain that there is no animal which would more excite our admiration than the sheath-fish, if we could see all that Pliny re-

lates of them. He mentions that they are not only luminous in some certain circumstances, as divers rotten fish and other sort of flesh are in the dark; but that the more fresh they are, the more light they diffuse; that they are full of a water whose nature it is to be luminous; it shines in the mouth of those who eat them; if a drop of it falls upon the ground, upon the cloaths, or upon the hands, those drops appear with all the splendor of light; in a word the nature of this liquor is the same as that of luminous bodies. Vid. Pliny, lib. ix. cap. 61. In vain did I seek, says Mr. De Reaumur, for this property in the sheath-fish, and was inclined to think it a mere fable of Pliny's; but I have since found that I was only deceived by Rondelet, Aldrovande, Gesner, Jonston; in a word, by all the modern naturalists who have without hesitation taken the fish mentioned by Pliny, under the names solen, aulos, donax, onix, dactylus, and most commonly dactylus, for what is called *coutelier* on the coast of Poitou, and *couteau* on the other coasts of the kingdom. It is to the dactylus that Pliny attributes the property of shining.

I have lately discovered that we have another shell fish, which produces all the phenomena that Pliny hath related of the dactylus. By its name likewise it resembles more the dactylus of Pliny than the *coutelier* or sheath fish. It is called *dail* on the coast of Poitou. Not

Not that I think the modern naturalists have been deceived in giving the name of coutelier or sheath-fish to the dactylus of Pliny; for the sheath-fish resembles more the dactylus of Pliny in its shell than the dail. Perhaps Pliny considered the dail as a species of the same *genus* as the sheath-fish; and not having seen the fact himself, but taken it on report, hath attributed to *one* species what is peculiar to *another*.

Surprising
lustre of
dails or
dottle-fish.

However that be, for there is a real difficulty in the case, yet it is certain the dails are luminous to the degree, and in all the circumstances, which we have just mentioned from that author.

It is scarce necessary to take notice, that it is not the shell which is luminous, but the animal, that it covers. It is more luminous in proportion as it is fresher, and but newly taken from the sea. In glow-worms it is but a part of the body which shines, whereas the dails shine throughout the *whole*. I have taken them entirely out of their shells, and carried them into a dark room; their whole surface appeared luminous, there was not so much as a dark spot, not a point that did not shine with a peculiar splendor. It is not to the external skins alone that this property is attached, it is common to all their flesh, to all that composes their body. If you tear them, cut them, the surfaces which are formed by those divisions are luminous, as
the

the others were ; in a word, their whole substance is luminous in the same manner as are the fragments of a coal that is thoroughly lighted, or as the urinary phosphorus is in every part. Our dails are true natural phosphori, which like the artificial phosphorus make all the bodies against which they are rubbed become flaming ; the fingers can scarce touch them without being luminous ; and, as Pliny says, they will shine in the mouth of those who eat them, and make the tongue, the teeth, and all parts of the mouth to which they have been applied, become luminous. This shell-fish newly caught hath, like oysters and muscles, a great deal of water ; if you handle it a little, drops fall from it, and those drops themselves are luminous, as Pliny exactly relates.

The light that these fish give to bodies, against which they have been rubbed, is not of long duration ; it ceases as soon as what they have left on those bodies is become dry. When I have neglected to wash my fingers immediately, I have seen the luminous quality which they had acquired grow weaker by degrees, and at length entirely disappear. But when I wetted my fingers afterwards in order to wash them, I perceived them almost as luminous as they had been before. This gave me an inclination to try if one might not make of this fish a durable phosphorus, a phosphorus that one might

might preserve as long as one would. I caused therefore some to be dried, which in drying have, as I expected, lost their property of shining. At the end of four or five days, when the flesh has been well dried, I have moistened them either with common water, or with water in which sea salt has been dissolved. Then they began afresh to shine, as I had expected; but that splendor being much fainter than the first, I concluded that these fish would not become again a very splendid phosphorus. I have endeavoured to preserve them by other ways, which have not succeeded better. I have put one of these fish in brandy, it lost almost immediately its whole property of shining.

It was towards the end of autumn that I made these experiments; then and at any time when the weather is not too hot, you may keep these animals *shining* for several days; but in proportion as they grow stale, they become less shining; and when corrupted to a certain degree they are no longer *so* at all. Perhaps likewise some of these shell-fish that are extremely corrupted may hinder those that are quite fresh from shining; an experiment gave me reason to think so. I ordered the fishermen to get some dails whilst I was present, which, on examining them in the dark, gave no lustre. It is to be observed that these fish live in the midst of a soft stone, which surrounds them on
all

all sides; that they are *there* in a kind of prison, from whence they never come out their whole life long; in order to get them you break the stone. Now amongst those dails, of which I was speaking, and that *fresh* gave no lustre, they had put some which had died in their holes, and were become excessively stinking. Perhaps the impression that *these* made on the others extinguished, if I may be allowed the expression, their whole light. I could not ascertain the fact, because I could get no more of the fish at that time. Perhaps likewise there are some seasons when these animals will appear more luminous than at others. The fermentation that there is in animal machines is not always the same, and one particular sort of fermentation may give to some kinds of flesh the disposition necessary to become luminous. The season when the animals *couple* is a time when there is a particular sort of fermentation. It is probable that the light, which glow-worms diffuse, owes a part of its vivacity to this fermentation.

Other insects likewise shine at particular times. I have met with millepedes that were very lively and of a common sort, which glistened at least as much as glow-worms; and I have often met with other millepedes, which have appeared to me of the same species, that were by no means luminous.

There

There may therefore be seasons when our dails would not shine, but I am not sure there are such seasons; and although I have found some that were not shining, though fresh, yet the excessively corrupted dails, with which they were mixed, might have contributed to this phenomenon, might have made *them* lose immediately the property of diffusing light, in like manner as I mentioned before that brandy occasioned *one* to lose it.

The dail was the only shell-fish on the coast of Poitou in which I found the property of shining. Before I conclude this article, I shall just mention that the dails are of the genus named *pholas* by the ancients; we have two species of them very common on the coasts of Poitou and Aunis. Their figure is pretty much like a truncated cone.

There is not probably in nature a progressive motion more slow than that of the dail; immured as he is within his hole, he advances only by approaching towards the centre of the earth; the progress of this motion is proportioned to that of the growth of the animal; as he increases in extent, he scoops deeper his hole, and by that means descends lower. He is commonly found at a depth double at least to the length of his shell. The part he makes use of for scooping this hole, is a fleshy part in shape of a lozenge, situated near the inferior edge of the shell. Although it is of a soft substance, there is no wonder

wonder that it should be able to pierce an hole deep enough in an hard body, as it employs on it a great deal of time. I have seen these dails employ this part for the use that I attribute to it, after having drawn them out of their holes, and placed them on a clay as soft as mud; they scooped themselves an hole, and in a few hours made it as deep as that on which they are labouring for several years; indeed they found *here* much less resistance, and the need they had of concealing themselves made them probably accelerate their work.

The young dails are found in clay, and the old ones in stone; from the shape of the holes corresponding to the figure of the shell, much narrower at the top than at the inferior extremity, it is certain that the old ones are in the same holes as when they were young; for should it be supposed that they quitted their first holes, and had an artifice of enlarging them at the top when they had a mind to quit them, it would be sufficient, in order to shew the falshood of such a supposition, to take notice that all the empty holes which are found are conical, like those that are inhabited; whereas if the dails had quitted them the empty holes would be cylindrical.

The consequence to be drawn from the preceding facts is extremely clear, that the stone hath been formed since the dails penetrated.

trated. Indeed there is no room to doubt but the sea water is proper for petrifying; pieces of wood, that one frequently meets with upon our coast more than half petrified, are an incontestable proof of it. It is highly probable that the dails live a long time; for the change of clay into stone, which is effected during the life of a dail, can proceed but slowly and by imperceptible degrees.

The dail hath likewise two tubes which it puts forth at the entrance of the hole. The use of them is the same as that of the tubes of the lavignon and other shell fish; they employ them alternately in sucking in and rejecting water. When you touch their hole, they draw them back quick into their shell, and, squirting out the water they contained, make several little spouts.

Memoirs 1712, pag. 119 to 133; Memoirs 1723, pag. 200.

Remark
on the
glow-
worm.

Having mentioned glow-worms in the preceding article in speaking of the lustre of the dail, I must observe that it is seldom but in the warm seasons that *they* shine in this country, and that those who do shine are all females. It is well known that they are insects without wings; but those, who have read the authors that treat of insects, know likewise that the male of this insect hath wings; the figure of the male is well represented

sent in Moufet's theatre of insects: he flies by night, and the female glow-worm throws out a light, like Hero for Leander, to direct him which way to steer his course.

I knew not the male of the glow-worms but by books, it had never yet happened to me to find any; when a female glow-worm luckily gave occasion some years ago to my discovering one. I was holding in the night-time a glow-worm in my hand, and observing the vivacity of its light, when another insect came and placed itself on my hand; it consoled immediately with the glow-worm, and continued a good while in copulation. Since *that* it hath happened to me several times to take other male glow-worms by holding females in my hand. Moreover there are seasons when the female glow-worms do not shine scarce at all, and perhaps those seasons are when they have no amorous disposition.

Memoirs 1723, pag. 203.

We have been diverted from the consideration of the razor or cutler-fish, and shall now return to observe that this animal which inhabits a cylindrical shell, resembling a round sheath of a knife, keeps itself always perpendicularly sunk in the sand, but in such manner that its head is always uppermost: its head is distinguishable, not by its figure, but by two tubes, which receive and reject

Of the razor, cutler, or sheath-fish.

water necessary for its respiration. The lower part of the sheath-fish is that which serves for its progressive or perpendicular motion; this motion is confined to a foot and half, or two feet of vertical height, and is effected by means of a kind of leg that it emits from its shell. Having a power of varying the shape of the extremity of this leg, so as to make it somewhat *pointed*, in order to penetrate through the sand, or to *swell* it into the figure of a bowl, in order to increase the surface, and consequently the resistance from the sand, it can sink down or raise itself up, to such an height, however, that the inferior part of the shell is always under sand.

It is easy to make the sheath-fish perform these two motions; when the tide being out hath left bare the hole where he lodges, you need only throw into it a little salt, and the sheath-fish immediately rises half out; it is easy then to take him; but if you would see him sink back into his hole, you need but touch him; after *that* if you throw in ever so much salt he rises up no more, but is sensible of the snare that is laid for him.

Mr. De Reaumur thinks that it is through an aversion to the salt thrown in, and in order to shake it off and rid himself from it, that he rises out of his hole; for if you put salt upon those tubes or horns with which he respire water, little cylinders placed end-

ways on each other, of which those tubes are composed, separate at the *places* of their joints, *which* have been touched by the salt, and fall off, or need only be touched very gently to make them fall; it is plain, therefore, that salt destroys an organ that is absolutely necessary to the animal. Strange that he should live only in salt water, and yet that salt should be so contrary to him!

History 1712, pag. 13, *Memoirs* pag. 119.

This shell-fish, which is a kind of great muscle, consists of two large shells, rounded at the top, and very pointed at the bottom, very uneven without, and very smooth, and of a brown colour within, inclining towards the point to the colour of mother of pearl: there are of different sizes from one foot to two and half in length, and have in their widest part about one third of their length; their shells are so thin that they are transparent. What is the most remarkable in them is a kind of tuft about 6 inches long; this tuft is situated towards the point of that side which is opposite to the hinge; it is composed of several filaments of a very fine and brown silk. These filaments by the microscope appear hollow, if burnt they give an urinous smell like silk. The ancients have named this tuft of threads byssus, whether on account of its resemblance to the byssus, from whence they spun their precious stuffs, or

Of the pin-
na marina.

Plate 3d,
fig. 2d.

whether it was itself the byssus of which they made those stuffs; for the most skilful critics have not well cleared up what was meant by the byssus of the ancients; they have only distinguished two sorts of it, the one of Greece, which was to be found only in the province of Elis, and the other of Judea, which was the most beautiful. The scripture informs us that the latter served for the ornaments of the priests, and likewise that the rich man in the gospel was cloathed with it; but as under the name of byssus the ancients confounded cottons, wads, in a word, every thing that was spun, and was more precious than wool; it is not easy to say what their byssus was, and whether it was not entirely taken from the shell-fish we are speaking of. This is certain that Aristotle names the silk of these shell-fish byssus, that it can be spun, and that there can be no doubt therefore of its having been employed in the dress of great persons in those ages when silk was but little known, and very rarely seen. In reality this byssus, although grossly spun, appears much more beautiful than wool, and comes pretty near to silk; there are made of it even at present stockings, and other manufactures, which would be more valued if silk was less common. In order to spin this sort of byssus, they leave it for some days in a cellar, to moisten and soften it; next they comb it to get out the filth that there may be in it; afterwards

terwards they spin it in the same manner as silk.

The fish that afford the byffus, make use of it to fasten their shells to neighbouring bodies ; for as they are placed upright on the point of their shells, they have need of these threads which they extend round about them, like the ropes of a mast, to support themselves in that situation.

It is probable, says Mr. Geoffroy jun. that the pinna-marina forms these sorts of threads, by the same mechanism as Mr. De Reaumur hath discovered in the sea muscles ; but those of the pinna are more beautiful, more silky, and, as Rondelet says, are as different from the threads of muscles as silk is from hards of hemp, as may be seen by comparing them together.

Mr. De Reaumur hath since examined the structure of the pinna-marina, and found the mechanism to be the same as in the muscle : the only difference is, that as the pinnae must rope threads much finer and longer than muscles, their wire-drawing part is likewise much longer and more delicate.

Memoirs 1712, pag. 207, *Memoirs* 1717, pag. 183.

Pliny, *lib. ix. cap. 36*, ranks all the species of shell-fish, which give the purple dye under two kinds ; the first comprehends the small species of *buccinum*, a name which the

Of the purple of the ancients.

ancients gave to those sorts of fish, whose figure of shell bore any resemblance to *that* of an hunting horn; and the second comprehends those shell-fish that bear the name of *purple*, as well as the tincture they afford.

Columna thinks, and hath probable reasons to support his opinion, that it is likewise this last kind which was called *murex*; that these different names have been given to this shell-fish, considered in different respects: the name *murex* excites the idea of channelled points with which their shells are rough, as the name of *purple* recalls the idea of the colour derived from them.

Our coasts upon the ocean do not afford any of the last kind of shell-fish; but one meets with very commonly a little species of *buccinum*, which furnishes a purple dye. I have not observed on our coast that species of *buccinum* mentioned in the philosophical transactions, Lowthorp's abridgement, vol. 2d, pag. 823. And I have but seldom found that which Columna hath got engraved in his treatise on the purple, as the true *buccinum* of the ancients; but I have not seen in it any of that liquor which gives the purple, as I have in the other *buccinum*: perhaps the difference of seas, or the difference of seasons, in which I made my observations, are the occasion of it.

The largest of the species of *buccinum*, common on our coasts, is between 12 and

13 lines long, and between 7 and 8 in diameter, in the place where they are the biggest. Their size agrees very well with Pliny's account of the buccinum, which he calls *minor concha*; he describes them more particularly still, when he adds that they are snipped at the edge of their mouth, *rotunditate oris in margine incisa*; ours are so likewise. There are of different colours, some white, others brown, others have streaks of a sand colour along the spirals of the shell, upon brown or white grounds; the external surface of these shells is commonly chamfered, but in two different manners; the chamferings of some are formed by kind of wreaths running the length of the spirals; and others have likewise other chamferings that run across the first, and consequently cross the spirals of the shell.

Plate 3d,
fig. 3d.

Their progressive motion is performed in the same manner as *that* of snails, by means of a large muscular part, to which we may give the name of foot or *pastern* in snails; all the other sorts of *spiral* shell-fish have a part very much resembling *this*, and destined to the same actions; this part is never seen but when they would move themselves, at other times it is intirely drawn back into their shells; it serves even to shut them up *there*, by means of a little lid or cover that is fastened at its end: this little cover is given to all these sorts of shell-fish, in order that they

Vid. plate
3d, fig.
4th.

Vid. fig.
4th, C.

may be closed on all sides, as well as the *bivalvular* shell-fish; it is composed of an hard substance, although less hard than the shell. One may easily apprehend how these animals stop up with this cover, as with a sort of gate, the mouth of their shell; for it must be observed that this cover is attached to the superior surface of the end of their pastern, that is to say, to that part of the pastern, which being extended is nearest to the summit of the shell. Now it is easy to conceive that when these shell-fish have drawn back their foot or pastern into the shell, by bending it in such manner that the inferior part, or that which was applied to the ground, is brought back towards their head; it is easy to conceive, I say, that this cover will *then* stop up the mouth of the shell, since the surface of the pastern to which it is fastened will by that means be the nearest to the mouth; and all that is requisite for the purpose is, that the shape of the cover should be the same as *that* of the mouth of the shell.

Upon breaking the shell at some distance from its mouth, or head of the buccinum, and taking out the broken pieces, you discover a little vein, to use the expression of the ancients, or to speak more properly, a little reservoir, full of a liquor proper for giving the purple dye: the colour of the liquor contained in this little reservoir makes

e
n
e
e
a
t
l
r
e
o
o
e
e
e
o
r
s
,
s
o
e
d
e

e
,
i
f
a
r
-
s
t

Fig. 2.

Fig. 3.



Fig. 4.

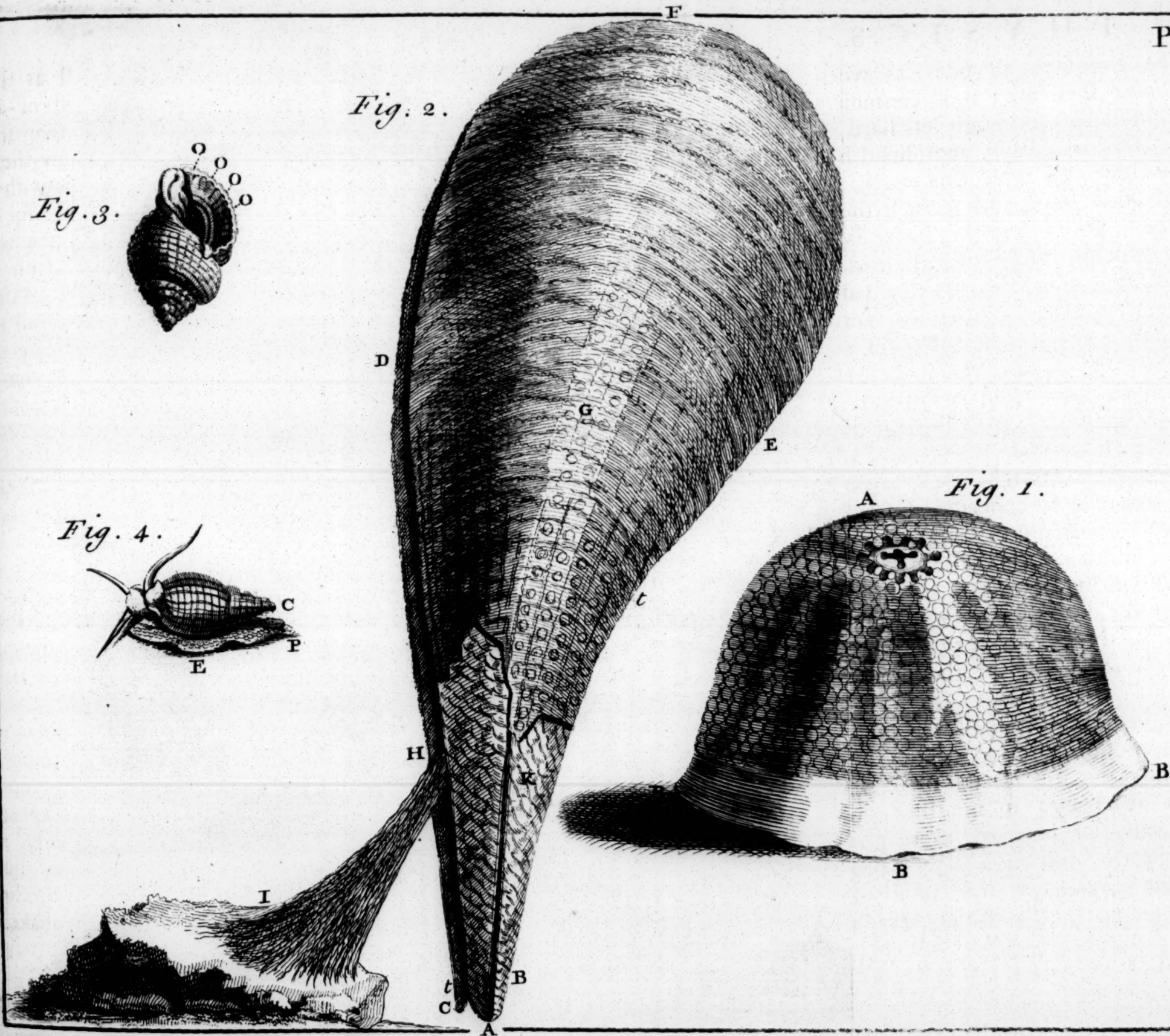
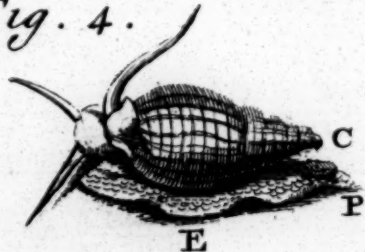


Fig. 1.

2012 Y H 7

It is this latter view that the students were obliged to take out of the discussion. It was to have the subject continue; they must not let it out separately from each other.

it easily distinguishable, it is very different from that of the flesh of the animal. Aristotle and Pliny mention that it is white, and indeed it is of a colour inclining to white, or a yellowish white: I shall excite a disagreeable idea in mentioning the pus of ulcers, but at the same time a very proper one to convey an exact image of the colour of this liquor. The little reservoir in which it is contained is not of equal bigness in all; it is commonly, however, about a line broad, and two or three lines long: you will easily conceive its position if you consider the buccinum as a land snail, indeed it is a kind of sea snail, and consider the snail as stripped of a part of its shell, so as to leave bare its collar, or that mass of flesh which surrounds its neck; for it is upon this collar that the little reservoir we are speaking of is placed; its origin is some lines distant from the edge of this collar, and on its most elevated part, that is to say on that part which is uppermost, when the mouth of the shell is downwards. This reservoir runs in a direction conformable to the body of the animal, that is to say, it goes from the head towards the tail, not in a straight line, but winding the spiral of the shell.

It was this little reservoir that the ancients were obliged to take out of the buccinum, in order to have the liquor it contains: they must have cut it out separately from each fish,

fish, which must have been a tedious work if you consider the quantity that is to be collected from it; for there is not so much as a good drop contained in each reservoir. No wonder that the fine purple was at so high a price amongst them. Aristotle and Pliny mention indeed that these little reservoirs were not taken away *separately* from the *smallest* shell-fish of this species; that *they* were only pounded in mortars, which was a means of dispatching a great deal of work in a little time; and Vitruvius seems to give *this* as the general preparation, Architecture lib. 7, cap. 13.

It is, however, difficult to conceive how they could have a fine purple colour by this means; the excrements of the animal must have considerably altered the purple colour, when they were heated together, after being mixed in water; for the excrementitious matter is of a greenish brown, a colour which it communicated probably to the water, and must have changed very much the purple colour, because the quantity of this matter is incomparably greater than that of the liquor.

I am the more convinced of *this*, as I have observed, that the more you take of the flesh of the animal, in taking away its liquor, the less beautiful will the colour be.

The trouble, however, of getting out the little reservoir of liquor from each buccinum, was not all that was requisite: they threw

next

next all the little reservoirs into a large quantity of water, which they kept for ten days over a moderate fire: that they kept it so long a time over the fire was not because it was necessary in order to give the purple colour to the liquor, it would take it much sooner, as I have been well assured by a great number of experiments; but it was necessary in order to clear it of the flesh, and of the little vessel itself that contained the liquor, which being dissolved in warm water rose in a scum to the surface, and were skimmed off.

The cauldron they made use of was of tin; we make use of the like cauldrons at present for scarlet dying: copper cauldrons would give a colour that would alter *that* which you design.

The ancients dissolved a good deal of sea salt in the water, with which they mixed the liquor of the buccinum, or of the purples. I do not believe they did it because they supposed that the sea salt would render the colour more beautiful; but perhaps they employed it only in order to keep the flesh in the cauldron from growing putrid during the long time it was to continue there; for by growing putrid it would have spoilt the purple colour, as I have found by experience. I have made likewise several experiments, by which I am assured that salt doth not make the purple colour more beautiful.

In

In the *Journal des ſçavans* of 1686, they have deſcribed the ſingular changes of colours that happen to the liquor of the buccinum; if inſtead of taking out the veſſel which contains it, as the ancients practiſed, you only open it, and by ſcraping it get out the liquor, the linnen or other ſtuffs, whether of ſilk or wool, that ſhall have imbibed the liquor, will ſhew at firſt only a yellowiſh colour like to what *pus* would give; but the ſame linnen expoſed to a moderate heat of the ſun, ſuch as in a ſummer morning, takes in a few hours very different colours. The yellow begins at firſt to appear a little more greeniſh, it becomes a citron colour; to this citron colour ſucceeds a more lively green; this green changes into a deep green, that terminates in a violet colour; after which you ſee at laſt a very fine purple.

Theſe changes are made ſo much the quicker as the heat of the ſun is greater; you have ſcarce the time to perceive them *diſtinctly*, when the linnen is expoſed to the rays of the ſun at noon in ſummer.

Not only the heat of the ſun, but likewiſe that of fire produces the ſame effects: yet it is a fact worthy of remark, that the ſame degrees of heat from the fire and the ſun are not equally powerful in producing the colours; the heat of the fire muſt be much greater than that of the ſun to produce the ſame change of colour in the liquor,

liquor, as I have been convinced by experiments.

The air alone without sunshine, or the heat of fire, will produce the colours, but more slowly; if the liquor is thick, such as it is when taken from its reservoir, you must expose it to an high wind, and then it takes in a few hours the same colours successively as it would in a moderate sunshine.

It may appear surprising that Aristotle and Pliny, who mention so often the tincture of purple, and the shell-fish that afford it, have not said a word of those changes of colours so worthy of remark, through which the liquor passes before it arrives at purple. It cannot surely be thought that they have neglected to tell us so singular a fact, because it was too well known in their time; I am satisfied that such a reason would not have induced them to pass it over in silence: it is much more probable, and I think it the true solution of the difficulty, that they did not know it, because they had not much examined these shell-fish *themselves*, and have only given us on this subject as on many others the accounts that had been communicated to them. Those which they had on this article must have been given them by workmen employed in the purple dying, or by persons that had seen them work, and who could say nothing of a change that did not happen in the ordinary preparation of purple;

purple; for it must be observed that the liquor passes all of a sudden to a red, when it is diluted in a great deal of water; and, as we mentioned before, their method was to mix it in cauldrons with a great quantity of water.

A new
purple discovered.

Whilst I was considering, says Mr. De Reaumur, the shell-fish I have been mentioning, I chanced to find on the sea shore a new tincture of purple, which I was not in quest of. Chance hath almost always a share in our discoveries, and all that attention can do is to push *luck* to the improvement of natural knowledge, as at play to the improvement of one's fortune. I observed that the buccina (for I would preserve to them their Latin name) were commonly collected together round certain stones, or under arches of sand, which the sea had made hollow by washing away the sand underneath. I remarked, I say, that the buccina were assembled sometimes in such great quantities in these places, that you might gather them up in handfuls *there*, whereas they lay widely dispersed every where else. I observed at the same time that these stones or arches of sand were covered with certain grains, whose figure somewhat resembled an oval. The length of these grains was somewhat more than *three* lines, and their thickness somewhat more than *one*; they appeared to me to contain a whitish liquor, inclining to a yellow.

This

This resemblance in colour to the liquor of the buccinum, and the manner in which the buccina were always assembled round these little grains, gave me a notion that there might be drawn from them a purple tincture, such as is drawn from that fish: I must own that a conjecture can scarce have a more slight foundation: however I took some of the grains immediately from the stones to which they were adherent, and making use of the first linnen and the least coloured that presented itself at the instant, I squeezed some of the juice upon the ruffles of my shirt; they appeared to me to be a little soiled by it; but I saw no other colour than a yellowish cast, which I discerned with difficulty in certain places. Divers objects that drew my attention made me forget what I had done to my ruffles; I thought no more of them, when casting my eyes by chance upon my ruffles a little while after, I was struck with an agreeable surprise; I saw a very beautiful purple colour on *those* places where the grains had been bruised. I could scarce believe a change so quick and so great; I repeated the trial by wetting my ruffles with the juice of some others that I pickt out with care, as the whitest or rather least yellow; I squeezed them on places of my ruffles untouched before, which at first gave no colour that approached to red; yet I had scarce fixt my eyes on them two or three minutes,

minutes, but I saw them take a purple colour like *that* which the former grains had given; this purple colour is at least as beautiful as what is drawn from the buccinum: my only fear was that it would be more fading, and consequently less proper for dying. The sea water served immediately to clear up this point, I washed my ruffles in it as much as I could, without perceiving any alteration in their new colour, and they have preserved it, notwithstanding a great number of washings through which they have passed *since*; I must own, however, that each washing weakens it, although it doth not entirely remove it.

The reader will imagine that my curiosity was rowled at this new discovery, and that I gathered up as many of these grains as I could before the tide came in, in order to make experiments at home. No sooner was I got into my closet than I began to squeeze out the juice of some of them upon different pieces of linnen; but the success did not answer my expectation, and I had as much reason now to be surprized at the failure, as before at the production of so sudden a colour. In less than two or three minutes my linnen had passed from white to red in my first experiments; and now at the end of two or three hours I did not perceive the least alteration. I knew that there was nothing which brought out the colour of the liquor
of

of buccinum so speedily as the heat of the sun or fire; but I recollected that there had been no sun-shine at the time of my experiments on the sea shore. However to be satisfied on this head, as there was no sun-shine at present, I placed the linnen that had been wetted with the liquor of the grains very near the fire; they dried there, but without any change of colour.

Confounded, and not knowing what else to have recourse to, I was preparing to return to the sea side, to see if the grains I had brought from thence would resume their power, or had entirely lost it by being transported; when casting my eyes by chance towards the window of my room, I perceived some spots of a beautiful red, such as I was seeking; these spots were on the plastering of the wall of the window: the liquor of some grains, that I had squeezed near the window, had spurted on the wall, and *there* taken the colour that had slipped away from me. In pursuing this Proteus, my first notion at the sight of this colour in the window, was that the alkali of the lime contributed to its production, and that my ruffles might retain, from their washing, enough of that salt to produce the effect. In order to assure myself concerning it, I took off a piece of the plastering from the window, and having put it on my table I wetted it with the liquor of the grains; but it only

VOL. I. I served

served to confound my reasoning, and to baulk my expectation, for no colour appeared. At length I went and squeezed some grains on the plastering at the window; scarce had I continued a few minutes to observe what effect the liquor would produce, but I saw the purple colour appear. This led me to conjecture that if I placed the pieces of linnen that I had wetted with the liquor near the window, *they* also might turn red like the plastering.

This conjecture soon ripened into certainty, for no sooner had I placed the linnen on the window, than I saw it tinged with a beautiful purple.

The cause of so sudden a change was then easy to perceive; that since my linnen had continued to preserve the white colour of the liquor with which it was wetted, whilst I left it in the middle of my chamber, and on the contrary had taken a purple, when I put it in the window, this effect could be attributed only to the different manner in which the air acted upon it in these different circumstances. Who could have devised that a little more or a little less circulation of air should have produced so suddenly such a diversity of effects? For it must be observed likewise that the casements of the chamber were all the time open: all the experiments I made afterwards confirmed this opinion that it was the air alone which caused the

the difference. It happened even when I exposed pieces of linnen wetted to the open air, in the midst of a court, and, to prevent the wind from blowing them away, put some little stones upon the corners, that all the corners, on which the stones rested, did not change their colour at all, whilst the rest of the linnen took a very beautiful purple; the effect of a greater or a less impression of the air shewed itself in a very sensible manner, when I exposed some of this liquor in a glass or tea-cup on a place where the wind blowed freely; all the upper surface was coloured red, whilst the inferior remained whitish.

N. B. *I cannot forbear throwing in a query, how far these experiments and observations may tend to give light into the nature of sanguification in animals, and to make it probable that air mixes with the blood in the lungs? An useful reflection may be drawn likewise from the great diversity of effects occasioned by a little more or a little less air, which may solve many difficulties in the animal æconomy, and shew the mischief of a closer, and the benefit of a more open air, even in such small degrees as one should otherwise have thought inconsiderable.*

Whatever experiments I have tried, says Mr. De Reaumur, they have not been successful

cessful enough to discover to me what those little grains are: I make no doubt, however, that they are the eggs or spawn of some fish, but in vain have I attempted to find what *species* of fish produces them; they are all of such a determinate bigness as the eggs of the same species should naturally be; and in whatever season you observe them, you find no change either in their length or thickness, which hinders one from conceiving them any ways vegetable.

As the buccinum appears commonly assembled in great numbers round about these eggs, it gave me great inclination to believe them the spawn of that fish; yet they appear somewhat too big to come from so little a fish: all the experiments I have made have not been able to clear up that point. In vain have I dissected abundance of buccina at different times; I could never find such eggs in their body. I have shut up buccina in earthen pots put into the sea, in such manner that the water had a free passage, and yet no such eggs or spawn was to be found there, which I think must have happened, if it had truly been their spawn.

This, however, is certain, that those grains are either the spawn, or the nourishment of the buccina, which they are extremely fond of; for otherwise why should they assemble so much about those grains? But uncertain must we remain whether the
buccinum

buccinum gives the purple liquor to these grains, or on the contrary derives its own purple from them.

I have sought with great care in the writers of natural history, and particularly in Aristotle and Pliny, to see if I could find any thing that could give light in this subject, but I have not found any passage where they have spoken clearly of it.

One single passage in Aristotle appeared to me to have some relation to it, but having well considered the whole I remain uncertain whether Aristotle meant to speak of those grains that are the subject of our enquiry. This passage is at the end of the 13th chapter of the 6th book of the history of animals, and I will give it in the Latin version of Gaza.

Defertur ex ponto in bellespontum purgamentum quoddam illius maris, quod algæ nomine phycos appellant, colore pallidum, florem algæ id esse alii volunt, atq; ex eo fucariam algam provenire: fit hoc æstatis initio, eoq; tum pisciculi tum ostreæ hujus loci aluntur; purpuram quoq; suum florem hinc trahere, nonnulli existimant.

There are in reality in this passage several things which seem to agree to the grains we are speaking of. The pale colour he gives to that species of fucus is the same as of our grains; the inhabitants of the sea coast (for instead of *alii* in the Latin, the Greek text

gives it the *fishermen*) consider it as the flower of the fucus, from whence the alga afterwards comes; which is very conformable to what our fishermen think, who take it for the grains or seed of the same plant.

Lastly, he adds that the purple-fish derive their liquor from it; for the expression *flos purpureæ* in Aristotle means that liquor. Now this agrees well likewise with our grains from which we may imagine the buccinum derives its liquor. We have given their resemblances, and shall now consider their disparities:

First, he says *fit hoc æstatis initio*, whereas our grains do not begin to appear until the end of summer, or rather the beginning of autumn. Next, these grains are so adherent to the stones that they are not easily separated. We scarce ever find any removed from the place where they were naturally fastened. Lastly, all that Aristotle says in this passage, may very well be understood of some little species of the *fucus tinctorius*. Shell fish feed on it; and it being proper to give the dye, it was natural enough to think that the purple-fish derived their colour from thence.

It is easy to conceive that the liquor of these grains might have been squeezed out in a manner infinitely more commodious than what the ancients made use of in order to get the liquor of the buccinum; all the labour requisite is to gather up the grains, of which there is great plenty; and after hav-
ing

ing washed them in the sea water to clean away the filth, which might otherwise by its mixture alter the purple colour, to put them under little presses, and squeeze out all their liquor in an instant. The liquor of the buccinum, on the contrary, could not be drawn out without employing a great deal of time.

Memoirs 1711, pag. 169.

It is commonly thought on the coasts of France and England, that soles are produced from a kind of shrimps or prawns. Nothing can have more the air of a popular and absurd story; *to compare small things to great, it surpasses in extravagance the fabled birth of Bacchus from the thigh of Jupiter.* Yet as it is possible, by disdaining too much such improbable stories, to be sometimes the dupe of our own contempt, Mr. Deslandes was willing to examine whether there was the least foundation for such a story, and hath discovered this piece of philosophy of fishermen and the common people to be founded on reason.

He got a large quantity of prawns to be taken, and put them into a tub, of about 3 feet diameter, full of sea water. At the end of 12 or 13 days he saw there 8 or 10 little soles, which grew by degrees. He repeated the experiment several times, and always found little soles. This was enough to justify

The surprising production of soles from shrimps or prawns.

the notion of the people. Encouraged by this he afterwards put some soles together with some prawns in the same tub, and in another tub he put soles alone ; it was in the month of April ; and in both tubs the soles spawned in perfection, but there did not appear any little soles but in that tub where the prawns were.

It is clear therefore that shrimps or prawns are of some use towards the production of soles. Mr. Deslandes hath observed, that when they are just taken out of the sea, you may discern between their feet several little bladders of unequal size and in great numbers, which are strongly fastened to their stomach by a gluish liquor with which they are smeared. If you take off these bladders, and open them gently, you see there a sort of embryos which have all the appearance of soles, particularly when looked at with a microscope.

Now here lies the mystery ; these are the eggs or spawn of soles, which in order to be hatched, have need of being fastened to the shrimps or prawns, in like manner as many plants and animals, which do not grow nor receive nourishment but upon other plants and other animals. The prawns therefore are in some sort the foster-mothers of soles during their first infancy, and this hath occasioned them to pass for their real mothers.

History 1722, pag. 19.

The

The learned are as much on their guard against the marvellous, as the vulgar give willingly into it. This is a prudent disposition of the learned, but yet they ought never to deny the most surprising facts, in the same manner as the people receive them; that is to say, without having examined them with sufficient care.

The wonders in
crawfish,
lobsters,
crabs, &c.

Those that frequent the shores of rivers or the sea assure us, that when crawfish, lobsters, crabs, &c. have by some accident lost one of their great legs, in the place of the leg lost there grows out another. What seems to prove it is, that one finds crawfish, for example, which have one leg much shorter than the other. Notwithstanding the probability arising from thence, the learned have without hesitation ranked this fact of a *reproduction* amidst the number of fables, and have attributed the inequality of the same pair of legs to an original defect of conformation.

I was induced, says Mr. De Reaumur, to examine into the truth of this affair, and in order to clear it up had need only to confine in vessels these animals after having cut off a leg, to see what would be the result.

I took some crawfish from which I cut off a leg, and shut them up in covered boats that the fishermen call *well-boats* or *trunks*, where they preserve fish alive. As I did not let them want food, I had reason to think that

I should *here* find, if at all, that reproduction I was in quest of. My hope was not deceived; for at the end of some months I saw new legs occupying the place of the old ones, which I had taken off; except in size, they were perfectly like the former, had the same figure in all their parts, the same articulations, the same movements. Such a source of reproduction doth not perhaps less excite our envy than admiration; if in the place of a leg or arm lost by *us* there shot forth another, we should more willingly embrace the profession of arms.

Nature furnishes us in these fish with a fair opportunity of admiring the divine providence. She hath given to craw-fish, and all the animals of that kind, long legs, which are to them in the place of hands; she hath made them big towards their extremity, and slender at their origin; as it naturally follows from this structure, and likewise from the shell with which they are covered, that they are easily broken near one of their articulations, she hath put these animals in a condition to repair a loss, which they are exposed to suffer even at the time they exert those motions only that the wants of life require.

The time necessary for the production of new legs is not determinate; it is one of the instances in which this kind of generation differs from that of the fœtus. These legs shoot forth and grow more or less quick, like
plants,

plants, according as the season is more or less favourable; the hottest days advance most their formation and increase. Divers other circumstances render likewise the reproduction more quick or slow; one of the most essential circumstances is the place where the leg hath been broken: to make myself more clearly understood it must be observed, that each large leg hath five similar joints; now if you break off the leg near the fourth joint from the extremity, it will *then* be reproduced with the greatest ease: and it is worthy of remark that the legs naturally break in that place; unless they are broken with design, you do not see them broke near any of the other articulations: it is not in the joint itself that the leg breaks; the joint is covered with a strong and flexible membrane: but the scale which is near the fourth joint, between that and the third, is composed of several different pieces, which is evident from two and sometimes three sutures that one perceives in that place. Now it is in these sutures, and particularly in the middle one, that the leg breaks; the pieces of scale are there but weakly fastened together, they do not apparently lock one into another; so that the leg may be broke by a very small force. If you cut off a leg at the first, second, or third joint, and go to examine the craw-fish some few days after, you will see with surprise that the legs, which you had
cut

cut at those joints, are all broken off at the future near the fourth joint; as if the craw-fish, well knowing that their legs shoot forth much faster when they are broke in *this place* than *elsewhere*, had the prudence to break them *there* of themselves. However I have several times seen parts of legs, which had been cut off near the first, second, and third joint, reproduced from those stumps; but then they grew out much slower than those which have been broken at the future near the fourth joint; and most commonly, as we have mentioned, you will find the craw-fish have broke them off *there* anew.

We have already said that the summer is the most favourable time for this reproduction; *then* it is performed in four or five weeks, whereas it will scarce be completed in eight or nine months in the other seasons of the year: the little legs likewise, and the horns will be reproduced in the same manner. I was willing to know if the tail would be reproduced as well as the legs; for this purpose I cut off tails in different places, but there never came out parts resembling *those* I took away; the craw-fish always died a few days after: if you take off a claw or a part of a claw, the whole or the part returns again in the same manner as the legs. Nature restores to the animal precisely what it hath lost, but makes no addition.

This

This reproduction of legs affords strong objections against a very ingenious notion, which is supported by abundance of experiments; I mean the notion of those who think that all animals arise from those little animalcula, which are perceived, in thousands, *in semine masculo*. The legs, or parts of legs of crawfish do not surely arise from an animalcule, or a part of an animalcule: the formation of such an organical part as the leg, or the formation of the whole animal machine, are in the main equally difficult. If the leg be truly produced anew, why may not the whole animal be produced anew likewise? In a word, the leg, or part of a leg, doth not probably come from a leg, or a part, that was pre-existent, and indued with all the motions, of which the leg is capable, ever since the beginning of the world: why then should we be desirous of making the whole craw-fish arise from an animal, that hath been in life and motion ever since the great creation? The one surely is no more necessary than the other.

The reason why a leg is reproduced so fast in summer, and so slow in winter, I take to be this: the craw-fish, although carnivorous, and voracious animals, eat little or scarce at all, during seven or eight months of the year, and consequently are not in a condition to furnish the juices necessary for new productions; it is sufficient that they
are

are able to support life. During the winter they assemble several together in the same hole, and rarely quit it before the spring; then they begin to stir abroad, yet do not attempt much to catch fish or insects from the water, until the heat of the weather becomes very sensible.

The close texture of the shell, with which they are covered, hinders probably the perspiration from being greater, than what may be supplied by the nourishment they derive from simple water.

But as soon as they take more solid food, they have not only the nourishing juices that their preservation and growth require; they have enough likewise to furnish out the new productions.

It is probably the *surplusage* of this nourishing juice, which is employed every year to form a new shell to each craw-fish; there is not *one* but strips off his ancient covering, some indeed sooner and others later, but none before the month of May, nor after the month of September; by which it is clear that they never change their shells 'till after they have begun to eat solid food. Before they quit their covering, they cease to take any solid food for some days, as if they found themselves too full, and too much straitened by their ancient shell; or as if they knew that a few days of abstinence, by diminishing their flesh, would more easily separate the
ancien

ancient shell from *that* which is formed underneath ; if we may be allowed to give the name of a shell to a membrane, that is indeed thick, but as yet very soft.

It is easy to foresee this change two or three days before it happens. If you press with a finger either the large table or plate of scale that covers the head, and a part of the back of the animal, or some of the little plates that cover the tail, you perceive them give way ; being no longer supported by the flesh, they yield and sink down at a very light pressure. The softness of the shell at a certain season, and the finding of craw-fish shells, which are entirely empty, seem sufficiently to prove that the craw-fish do actually divest themselves of their shells ; but to speak the truth, these observations do not *demonstrate* it, nor take away all matter of reply : it might be supposed that there are craw-fish of different species ; that it is natural to some to have an hard shell, and to others to be vested only with a soft skin ; that there are craw-fish which resemble certain fruits ; that we see almonds, for example, whose shell cannot be broken but by an hammer, and others again whose shell breaks with the pressure of a finger. Perhaps it may be said that there are certain diseases, which soften the shells of craw-fish.

With regard to the empty shells one meets with, it may be said, that they are the *re-mains*

mains of craw-fish, which have been the prey of other animals.

The fact is surprising enough to make one have recourse to all the reasons that can bring it into doubt. It is scarce conceivable that an animal should divest itself not only of its shell, but likewise of all that it hath cartilaginous, bony, or analogous to bone; in a word of its whole *frame*; that a living animal should make as I may say its own skeleton, for such in reality is the empty shell that one finds.

Therefore to establish the fact, I have not trusted to the probabilities I have before-mentioned, nor to the unanimous report of fishermen; but have believed only my own eyes. Having picked out some craw-fish which appeared ready to moult, I put them in my closet into vessels full of water; and *there* having them continually before my eyes, I could at my ease see them quit their ancient shell. I have likewise observed them in the river itself; I ranged several pots full of holes along the brink of an arm of the river Marne, which runs by side my garden. In each pot I put several craw-fish, they had *there* continually fresh water; and in consequence of that have divested themselves much sooner than those which I had conveyed into my closet; for it is too oppressive to the animal to be incommoded at a time that he is already sick, and hath need of his whole strength.

strength. I saw however, the same preliminaries *there* as in my closet; some hours before the crawfish is ready to strip himself, he rubs his legs one against another, without changing place, stirs them likewise each one separately, throws himself along on his back, turns in his tail, and next extends it, agitates his horns, in short exerts all those motions that tend to give each of those parts a little looseness in their *case*.

After these preparations he swells and puffs up his body more than it is usually; then the *first* of the tables that covers the tail, appears disjoined a little from the large table that covers the head, and may be called the helmet, although it covers likewise the stomach, and other internal parts. The membrane that unites this helmet with the first table breaks, and the body of the craw-fish appears; the body is easy to be distinguished, it is of a dark brown, whereas the old shell inclines to a greenish brown. I shall mention by the way that it is by this last colour that one knows *those* which have not yet moulted, and that the more they are of a brown and dirty green, the nearer they are to moulting.

They do not labour to divest themselves of their shell immediately after the preceding rupture; they repose themselves for some time; afterwards they begin again to agitate their legs, and all their other parts; at length the instant being come, when they think

VOL. I. K themselves

themselves able to get rid of a troublesome covering, they swell and puff up the parts which are covered by the helmet: the helmet is raised up and separated from those parts where the legs take their rise, it becomes loose, the membrane which held it along the edges of the belly-part breaks, it continues only fastened about the mouth; you see jutting out all round the helmet that part of the body which was before covered by it.

From the instant above-mentioned, to the time that the crawfish becomes entirely naked, there doth not pass more than a quarter of an hour when it moults in the river; whereas in my closet they have been in labour for several hours: as they were *there* less at their ease, they have sometimes given themselves much more turmoil and motion, which hath occasioned the helmet to be entirely detached, whereas in the river the helmet hath continued always fastened about the mouth.

The helmet being lifted up to a certain degree, you see its edge spreading out from the first of the tables; the crawfish then draws his head backwards, and dislodges his eyes from their *cases*; at the same time he disengages a little all the other parts of the fore-part of the head; the legs themselves are drawn a little backwards, for there is but one pair that is articulated beyond the helmet.

helmet. At length after having swelled himself several successive times, he draws his whole body backwards, and uncases either one of the great legs, or all the legs of one side, or a part of those on one side; sometimes those of both sides are disengaged at the same time; for it doth not pass in one uniform manner in all crawfish: the legs are sometimes so difficult to be drawn out, so closely confined within their *case*, that they break off and remain behind. All this labour is extremely violent to the animal; I have found several die in the operation, and particularly the young ones.

At last, when the legs are disengaged, the crawfish draws his head from beneath the helmet, and likewise the other parts which it covered, then darts himself forwards, extends suddenly his tail, and trails it out immediately; by this last motion he entirely quits his ancient *case*. From this last act of vigour he falls into a great weakness; all his legs are so soft that they bend, particularly in the places of their articulation, like wetted paper. Yet if you take up a crawfish immediately after he is come out of his shell, you perceive his body to be much harder than it is naturally: the hardness I speak of doth not resemble that of the shell; it is the entire mass of flesh which you perceive to be hard; the violent convulsions, into which the muscles are thrown, are perhaps the cause of it.

I would observe that when the helmet is once raised up, and that the crawfish have begun to disengage their legs, there is nothing capable of stopping them; I have often taken them out of the water in this state, proposing to myself to preserve them half stripped; they completed their moulting in spite of me even in my hands. In vain have I pressed the body, it did not hinder them from drawing their legs out of their sheath, and even with vigour. In fine they were often divested entirely before I could have the time to put them into brandy or vinegar, where I designed to let them die; sometimes even those which I have put into these liquors, so different from water, have still completed their moulting there.

We will now consider the shell that the crawfish hath just quitted; you would take that shell itself for another crawfish; there is nothing wanting to it externally. The piece which we have named the helmet being no longer supported, and being adherent towards the mouth, falls back to its former place; there is no difference observable between this carcass and an intire crawfish.

There is in the animal's stripping off its shell one circumstance that may appear inconceivable, which is, that a leg should come out of its scaly *case*, and that the only opening of this *case*, through which the leg could pass, should be so small that it is impossible

impossible the leg should have passed: but in fact it hath not passed through *that* opening, but the case hath a slit that is not discernible along its whole length, and is composed of two pieces so exactly joined, that they appear absolutely but one: this slit spreads itself open a little to give passage to the leg, and in a moment closes again so *harmoniously* that the slit disappears, as if nature had studied to conceal the method she employs to give passage to the leg. We have left the crawfish covered with a soft membrane alone, instead of an hard shell which he had before; he doth not continue long in this condition; I have sometimes seen this membrane assume all the hardness of the ancient shell in 24 hours; in general it doth not assume that hardness under 2 or 3 days.

The little time that this shell requires to harden is likewise one of the singularities which the crawfish affords us: it is important to the animal to have an hard covering, without which he is exposed to be the prey even of his own species; but, perhaps, the way that nature employs to give hardness to this shell is more singular still; at least if my conjectures prove true, and my observations can confirm what I think hath been advanced somewhere by Van Helmont.

I consider the two stones situated in the stomach, and known under the name of crabs eyes, as the matter prepared and laid up in

stone, in order to serve when occasion requires for hardening the shell. It is well known that those sorts of stones are not to be found at all times in the crawfish, you may trace their different degrees of growth by opening crawfish in different states; but, perhaps, it is not known that the crawfish, in which those stones are the largest, are the crawfish that are ready to moult; one finds them likewise in crawfish that are dissected immediately after moulting; but if one day after the moulting you open the crawfish, you find the stones much smaller than could be expected; and lastly, if you open the crawfish when its shell hath assumed all the hardness that is natural to it, the two stones no longer appear. Doth it not seem from thence that the one increases at the expence of the others? Since in proportion as the shell hardens, the stones diminish in size, and are no longer found when the shell is become hard; is it not reasonable to think that the stones are dissolved, and that the stony juice is carried and deposited in the interstices of the fibres of the skin or soft membrane? When the shell is arrived to a certain pitch of hardness, it permits no further entrance to those stony parts, but the hardness stops at that degree. We do not perceive the shell to increase afterwards either in thickness, or in any other way; and, perhaps, it is from thence that the crawfish are constrained to cast

cast their shells every year: their habit becomes too short and too strait, it confines them and obliges them to quit it. This conjecture appears strengthened by an observation I have made, and am assured of by a careful measuring, namely, that each part of a crawfish which hath lately moulted, is considerably larger every way than the case he hath quitted. It follows from hence, however, that the growth of a crawfish is extremely slow; for he grows only so much every year as the size of the new shell exceeds that of the old: the fishermen say that a crawfish, which is six or seven years old, is but of a moderate size.

We shall add before we conclude this article, that at the time the crawfish are ready to moult, there is in them another production much more remarkable than that of their shell; I mean the production of a new stomach; this fact hath been related many years ago by Van Helmont, but stood in need of a more certain testimony. Mr. Geoffroy junior hath given himself the trouble to examine into it, and hath really found a new stomach, which envelopes the old one; and what is more remarkable still, he thinks it probable that the old stomach dissolves, and becomes the first food which the new one digests.

Memoirs 1712, pag. 226, and *Memoirs*
1718, pag. 264.

Of bezo-
ard stones,
and pearls.

The first stones that bore the name of bezoard were brought from the east: since the discovery of America there have come from thence stones, which being pretty much conformable to the first in structure and in virtue, have likewise received the same name. There are likewise other stony substances, taken out of animals, and disposed in lays, which have been named bezoard, by adding to them the name of the animal, from which they were taken; such are the stones called *monkey bezoard*. Some taking the word bezoard in the signification of a counter-poison, have applied it indifferently to all substances that had this virtue; from thence it is that the name hath been given to chemical compositions, such as the mineral bezoard, &c.

From the observation that the bezoard stone was disposed in lays, the name hath been given to a sort of figured stone, such as is found in America, in different parts of the earth, and to which the same virtues are likewise attributed: we find this sort of bezoard in Italy, Sicily, and even in France, in different places, and particularly in Languedoc.

We have mentioned in general the different substances known under the name of bezoard: but to speak properly the bezoard is a stony substance, taken out of some animal, composed of several lays or coats, like

an onion, and which hath some virtue for resisting poison; the two principal species, as we have already said, are the oriental and occidental. We know in general that this stone is found in the stomach of a kind of wild goat that browses on aromatic plants. If Tavernier is to be believed, there are several of these stones found in the same animal, which may be known by the touch; the stones are of different figures and sizes; there are some which have the shape of a kidney, or a bean, others are round, oblong, or of an irregular figure: the middle or center of the stone is commonly occupied by some hard body. I have found in the center of several that I have opened, straws, hair, marcasites, flints, gravelly substances, united together, and as hard as stone: I have likewise found talc, wood, stones resembling cherry stones, nuts of various sorts, and pieces of nuts.

I imagine that the substances included in the bezoard serve precisely to indicate the manner in which it is produced: these solid and undigested bodies remaining in the stomach of the animal, may irritate the glands of it; and the lymph continually *thickening* together with the juices of the aromatic plants, that the animal feeds on, round those bodies or buds as Tavernier calls them, may well be supposed to form the polished lays.

I observe likewise that whatever body makes the center of this stone, the lays of it are so delicate and so well turned, that externally the stone hath the figure of the substance which is included within. Thus for example, if it be a straw, the stone will be long; if a flint, it will keep that figure, &c. insomuch that by the shape and weight one may guess what substance they contain.

Even the fossile bezoard is formed in the same manner, having in the center some foreign body, round which the bezoardic strata are formed and ranged: in the fossile kind Bocconi hath observed nuts of different sorts, flints, gravel stones, wood, metal, coal, &c. I have examined, says Mr. Geoffroy, some that are called *priapolites*, which grow in Languedoc; one of which, given to me by Mr. Bon, had the center occupied by a piece of rock crystal.

With regard to the animal bezoard we find several of those stones in the stomach of one single animal. Tavernier says, expressly, that six of those goats, which were made a present of to him, had *in all* 17 bezoard stones, that might be felt outwardly and counted; and that the value of the animal increased in proportion to the number of stones that were felt. This agrees perfectly with what Clusius relates of the animal that bears the occidental bezoard; he says that a friend he had at Peru, and who first discovered the occi-

dental bezoard, being desirous to know how those stones were formed in the body of these animals, dissected one, and found in the stomach a kind of pouch, where those stones were ranged in a row like the buttons on a coat.

These two passages are entirely opposite to what Pomet tells us, who pretends that there cannot be above one bezoard stone in the stomach of each animal. Indeed he assures us that he would not dare to contradict authors who have treated of it, if he had not in his hands a proof to justify his opinion: this affair is proper for our examination, and the more *so*, because no one that I know of hath publickly shewn the error of Pomet, on the pretended coat of the bezoard animal, which he says is one of the greatest curiosities that hath been seen for a long time in France.

This coat, says he, is about the bigness of a goose's egg, garnished outwardly with rough hair, short, and of a dun colour; which being cut open, you find *there* a thin and brown shell, which serves for a covering to another shell that is white, and hard as a bone, wherein is contained that stone to which the name of bezoard hath been given.

Pomet's treatise of drugs.

Now this so singular a covering, of which he pretends to have made the discovery, is not at all a part of the animal which bears the bezoard;

bezoard; it is an exotic fruit, in which Pommet, or some quack, by whom he let himself be deceived, had inched very dextrously a bezoard stone; this fraud was detected about a year ago. As I was examining with Mr. Vaillant, and Mr. De Jussieu, demonstrators of botany at the royal physic garden, this singular piece of the collection of Mr. Pommet, we were satisfied that this pretended covering could not be a part of any animal, and must be some fruit that was but little known; which was afterwards discovered to be true by Mr. Vaillant, who happened to have some of that sort of fruit, and with ease made with it bezoards, together with their covering, entirely resembling the bezoard so much valued by Mr. Pommet: the fruit grows on a sort of palm-tree described by John Bauhin, which he calls *palma cuciofera*; it is described likewise by Theophrastus: the tree grows in Egypt, Nubia, and Ethiopia. Cordus calls it *nux Indica minor*. It is of use to natural history to discover such frauds.

I place in the rank of bezoard stones all such substances as are formed by lays in the body of animals: pearls, which I rank of this number, deserve it the more, as I have found some of them in certain shell-fish so like to the common bezoard, that it is difficult to distinguish them at the first sight. These pearls are produced in the shell-fish called *pinna marina*, five *astura Matbioli*, of which

which there is great plenty on the coast of Provence. The pearls that are found in this shell-fish are not all of the same water; some are, as I have said, perfectly like bezoard stones; others are of the colour of coral and amber; others again of the colour of pearls, but more leaden; their shape is commonly that of a pear. All these different varieties of figure and colour do not hinder them from being of the same nature, since they are produced in the body of the same fish. That these pearls, as well as all others, are formed in the body of shell-fish in the same manner as the common bezoard in the body of those goats that supply it, is not difficult to be proved, since by breaking them one finds them streaked like certain bezoards, and formed round a kernel, which appears itself to be a little pearl. No one doubts but the oriental pearls are of the same nature as those which are produced in other shell-fish, such as in the oysters we commonly eat, and the different sorts of muscles: all the difference between them arises only from their different water; but there is through all the same matter, and the same construction, as is visible from the different pearls one finds in the pinna marina; we should, therefore, consider pearls as true bezoard stones in respect of their nature, although they are not entirely *so* in respect of their virtue.

I shall not relate, says Mr. Reaumur, all that the ancients have delivered fabulous on the origin of pearls; natural philosophy is too far advanced to require any proof that they are not produced by a celestial dew, notwithstanding all the assertions of grave authors: those who have taken them for the eggs of the fish where they are found do not deserve our regard any more than the others. Mr. Geoffroy jun. ranks them amongst bezoards, as he places in this class all stones formed in lays or strata, which are ingendered in animals: it is certain that they cannot be considered but as other stones, which are formed in animals, such as the stones of the kidneys, bladder, &c. They are probably likewise the effect of a disease of the fish; it is by no means surprising that an animal, that hath vessels where there circulates a sufficient quantity of stony juice to supply the building, thickening, and enlarging a shell, should have enough likewise to form stones, if there should happen an effusion of the juice, destined for the growth of the shell, into some cavity of the body, or between its membranes. The stone is called a pearl, when the juice that hath over-flowed, and of which it is formed, is of a silver-colour water, approaching to that of mother of pearl; and its colour is likely to be such in muscles, oysters, and other pearl shell-fish, whose very shell is of the colour of the *naker*.

As air and aliment render the inhabitants of certain countries subject to certain diseases, so undoubtedly the waters of seas and rivers, which fish respire and are nourished by, cause in them many disorders. From thence it is that nothing is more uncertain than the number of pearls found in those shell-fish; in some of the pinnæ marinæ I have found none at all, in others I have found twenty. Muscles of the same species have pearls in some rivers, and none at all in others; our oysters would perhaps be more *precious*, if the waters of our seas were less wholesome.

Memoirs 1710, pag. 235. Memoirs 1712, pag. 202. Memoirs 1717, pag. 186.

It is by no means surprising, says Mr. De Reaumur, that the worm I am going to give an account of should have escaped the observers of nature; it is rare, very small, and at first sight offers nothing very singular; yet if contemplated a little it appears very well to deserve our attention. The smallest insects, and the largest animals, all come from the same hand, and bear equally the stamp and character of the great Creator.

A singular species of aquatic worm.

This aquatic worm is no more than 7 or 8 lines in length, yet seems *itself alone* to compose a whole class; at least we know not any class of animals, under which we can rank him; terrestrial animals live on earth, aquatic in water, and the amphibious sometimes

on

on earth, and sometimes in water: This animal hath the two extremities of its body aquatic, its head and tail being always in water, and the rest of its body is always on land: to conceive how this is possible it is necessary to know its figure.

Like several insects it is composed of different rings; it hath eleven between the head and tail; they are all pretty nearly spherical, and resemble chaplets of beads strung one to another. This insect is almost always bent double, like a siphon; I mean that one of its parts is longer than the other, and that they are both almost parallel to each other, in such manner that the head and tail are always near the one to the other; the part that goes from the bend to the tail is a little longer than that which goes from the same bend to the head: it is, however, the sixth ring that is commonly in the middle of the bend; but the five rings towards the tail are larger than the five rings towards the head.

It is only the head and tail, and the ring the nearest to the tail, that are constantly in water, the nine other rings, or at least seven of the other rings are on land. The insect keeps itself at the edge of stagnating waters; a water much agitated would not suit it; as soon as the water covers it a little more than we have mentioned, it finds itself uneasy and removes; if on the contrary the
water

water covers it less, it draws nearer to the water in an instant.

The worm having no more than 8 lines in length, it would not be easy to make this observation when it is at the edge of a large piece of water : so that it is by examining it in glasses or cups full of water, that I have been able to perceive what I have just related. I saw it always fasten itself to the sides of the vessel, in such manner that its head and tail were in the water, and the rest of its body was out. If by inclining the vessel one way I obliged the water to cover it more, it removed itself as fast as it was able : if by inclining the vessel the contrary way I made the water leave it, it eagerly moved to get at the water which was wanting to it.

Moreover its *manner* of walking or creeping gave me occasion to examine it more closely; it appeared to me to deserve a place amongst the progressive motions of aquatic animals, of which I have already given an account.

In its natural manner of moving, it is the middle of its body that advances forward *the first* toward the place where the animal would approach ; that is to say, it is the sixth ring that is the most forward, and seems to lead the rest of the body, as it is the head that advances *first* in four-footed animals. In a word, whilst it moves it continues bent in the shape of a siphon, and the middle ring begins the progressive motion. It is not

with a vermicular motion that it advances in this manner; it hath legs, very small indeed, and whose shape can scarce be discerned without the assistance of a magnifying-glass: these legs are likewise one of its singularities. They are fastened to its back, that is to say, to the part opposite to its belly; from whence it follows that it lies continually on the back, with its mouth turned upwards. This last circumstance is not particular to it; we know some sorts of flies and aquatic insects which swim always on their back, because they feed on insects that swim or walk on the surface of the water: it is for the like reason that our insect hath its mouth turned upwards. The mouth is surrounded by four little hooks, in the manner of other voracious insects: from its middle there issue two little parts made in the shape of a tuft. The animal continually agitates these two little tufts, by lengthening them out, drawing them back again, and moving them from right to left. This little agitation keeps the water in a continued motion, and the little bodies that swim on the water are brought by this means from a distance, and sucked into its mouth. This is the artifice it makes use of for its nourishment. When it hath drawn some little body that it thinks a suitable morsel, it advances the head, seizes it greedily, and swallows it. I have seen insects taken in this manner
which

which were of extreme smallness, and could not be seen but with an excellent glass. Altho' what it takes in this manner is very small, yet it eats a great deal in proportion to its bigness, for there are continually little bodies entering into its mouth; we may well suppose that the greatest part of them are not a suitable nourishment. Besides its natural motion with its legs, it hath likewise a vermicular motion, which it rarely puts in use, and is always attended with difficulty. Its legs are so situated as to contribute to the motion we have already described, in which the middle advances forwards the *first*; but when it would move the head and tail the *first*, the legs can be of no service to it. To move itself in this direction, it hath only a vermicular motion.

Nature affords us in this single insect these several subjects of admiration, that the tail and head live perpetually in water, whilst the rest of the body lives on land, that it hath legs on its back; that when it moves naturally it makes the middle of its body advance the *first*, as other animals do their head.

Memoirs 1714, pag. 203.

Without such a testimony as that of Mr. Leibnitz, we should not dare to relate that near Zeitz in Misnia there is a dog that talks. It is a countryman's dog of a very common

A remarkable talking dog.

shape, and of a moderate size. A young child heard it utter some sounds, which he thought resembled some German words, and upon *this* took it into his head to teach it to speak. The master, who had nothing better to do, spared no time nor pains; and luckily the pupil had such dispositions as it would be difficult to find again in any other. At length, after some years, the dog could pronounce about thirty words: of this number are *tea, coffee, chocolate, assembly*, words that are current in all modern languages without much variety. It is to be observed, that the dog was three years old when he was put to school. He talks only by echo, that is to say, after his master hath pronounced a word; and he seems to repeat it by constraint, and against his inclination, altho' not beaten. It must be observed likewise, that Mr. Leibnitz saw and heard him.

History 1715, pag. 3.

N. B. *The academy thought it necessary to premise an apology for relating the fact, and I think it necessary to adjoin one for extracting it. I am induced to it in order to give an hint to some ingenious person for exhibiting a talking dog, as we have lately had a chien savant.*

On this occasion I cannot omit mentioning what the academy hath observed in another place with regard to apes and monkies. The
most

most perfect resemblance they have to *man* consists in the organs of voice; they have them *so* formed that the negroes have reason to say, without knowing it, that monkies could talk if they would; and that the greatest part of philosophers are to blame in supposing too generally, that the animals exert such and such actions, because it happens that they have organs suited to them. It is not owing to the want of organs that apes and monkies do not articulate sounds, and establish a language amongst themselves; it is owing to the want of a sufficient understanding; for one of the most admirable actions of *man* is that of speaking.

Vide tom. 1. anno 1674, pag. 179.

Mr. Luyd and Dr. Woodward have done honour to England in the discoveries they have made of abundance of stones, on which they have observed divers figured plants. Mr. Mill hath given us some observations on the like prints found in Saxony. Mr. Leibnitz had proposed to himself the task of marking out all the places in Germany, where those ancient footsteps of nature have been traced. And Mr. Scheuchzer hath set off Switzerland for its fruitfulness in these sorts of figured plants, the types of which he supposes existed before the deluge.

France may boast her riches in these commodities as much as those countries. Of this

I had the opportunity to be convinced in passing through the province of Lionois in my journey to Spain, as I went through the neighbourhood of St. Chaumont. The soil of that town as well as of St. Stephen in the forest, is well known to be abounding with pit-coal.

Recollecting that I had read in the letters of Mr. Luyd that stones imprinted with the figures of plants are most commonly found in the neighbourhood of coal-pits, I was very attentive to the figure, colour, and stamps, of all the stones I met with near any of the pits of coal. My attention was seconded by some patterns that were put into my hands by one of my friends, distinguished in that country for his taste in natural history.

With this guide I had the pleasure, even at the gate itself of St. Chaumont on the side of the little river Giés, to observe on the greatest part of the stones that I collected, the impressions of a vast number of fragments of plants, so different from all the plants which are the natives of that country or even of the rest of France, that I seemed to be herborising in a new world.

All these stones are *scaly*, and differ only in colour according as they lie nearer or more remote from the coal-pits; that is to say, those which are the nearest to a coal-pit are of a black and shining slate, in which they seem to partake more of the bituminous oil,
which

which is the most essential principle of pit-coal : whereas those that are more remote are of an ash-coloured grey, which a mixture of particles of talc causes to appear sometimes *bronzed* but most commonly *silvered*.

In both these sorts of stones, of whatever colour they be, the stamps are always more highly coloured than the rest, and distinguish themselves particularly in the grey ; sometimes the stamps are the only part that appears covered with a light lay of bronze or silver ; which is the effect of the facility that the vitriolic streams have had of stopping in the furrows of these prints, rather than in the rest of the surface of the stones.

They are different from the hard kind of dendritis, such as agates or flints, and from the soft kind such as razor stones and Florence stones, in *this*, that the figures, which are found in the stones just mentioned, penetrate quite through their whole thickness, like a foreign matter that hath insinuated itself into them, as the late Mr. De la Faye hath very well observed ; whereas in the stones of St. Chaumont the prints of the plants are only on the surface of the leaves of the stone, and in each leaf they are *all* different, and placed in divers directions.

History
1717,
pag. 3.

The number of these leaves, the facility of separating them, and the great variety of plants that I have seen impressed on them, made me consider each of these stones as so

many volumes of botany, which in one quarry compose, as I may say, the most ancient library in the world; and which are by so much the more curious, as most of these plants either exist no more, or if they still exist they are in countries so remote, that we could never have had any knowledge of them without the discovery of these prints.

There would be only wanting, in order to perfect this collection of botany, to give names to the plants that are imprinted on these stones; even in *this* one might succeed by the rules that have been lately established to determine the classes to which they belong: but as it is rare to find the plants entire, and one can discern only in general some fragments of branches, or some leaves, and as there are several which are crossed by others of different species, it would be difficult to characterise or to describe them with any exactness. We may however be assured that they are capillary plants, ceterachs, polypodies, adianthums, harts tongues, spleenwort, osmunds, and the several species of fern, resembling those that the reverend father Plumier and Sir Hans Sloane have discovered in the islands of America, and such as have been sent from the East and West-Indies to the English, and communicated to Plukenet for his collections of rare plants. One of the principal proofs that they are of this family is, that as *they* are the only plants which

which bear their fruits on the backside of their leaves, the deep impressions of their seeds are still distinguishable on some of these stones.

The multitude of differences in these plants is so great in the neighbourhood of St. Chaumont, that each place seems a new source of varieties.

Besides those prints of the leaves of capillary plants, I have likewise remarked some that appear to belong to palms and other foreign trees, together with some uncommon stalks and seeds; and upon scaling off some of the leaves of these stones, there has issued out a black dust, which was nothing else but the remains of a plant grown rotten, and inclosed between two strata, perhaps more than three thousand years ago.

There are in this affair three singularities which render it very remarkable; the first is, that we find not in the country any of the species of plants, whose prints are stamped upon these stones. This is a fact of which I informed myself by herborising with this view on the neighbouring mountains, and particularly on that of Pila in the Lionnois, distant from St. Chaumont about three leagues. The second is, that amidst this infinite number of leaves of different plants imprest on the laminæ of these stones, we find none that are folded, but they are all at their full extent as if they had been glued on. The third
singul-

singularity, more surprising than the other two, is that the two scaly laminæ of these stones represent each on their internal surfaces, by which they touch one another, only one single face of a leaf, in relief on one side, and *en creux* or hollow on the other; whereas in the usual manner of conceiving such impressions, it is natural to suppose that a leaf of a plant pressed between two soft earths, must leave on the surface of the *one* the print of its upper part, and on the surface of the *other* the print of the lower.

From what we have mentioned these following observations must necessarily result; first, that these plants unknown in Europe can come only from the hot countries; because if they resemble more perfectly the American plants than any others, and the same species of plants to which they are related are found only in divers parts of the Indies, it follows by consequence that they must have been brought either from those countries, or from some other whose situation is pretty much the same.

Secondly, that as their print represents them extended and often lying in different directions one upon another, they could be impressed in this manner only, because the water, on which they must have floated, kept them thus expanded.

Thirdly, that this water must undoubtedly have been the sea-water; this is evident from

the shells of fish that are found in the neighbouring soils, shells that have not any resemblance to fresh water shell-fish, but on the contrary, such as are produced *some* on our own coasts, and *others* on the most distant coasts with respect to us.

Frequent experience of the vicissitudes that happen to certain countries, whose lands are successively over-flowed and deserted by the sea, shews us but too well how possible it is that the waters, which I suppose to have transported these plants, might have covered those places of the Lionois; for without being obliged to have recourse either to the universal deluge, or to earthquakes that have made great openings through which the waters of the sea have been dispersed, not to mention the dreadful tumblings of high and vast mountains, whose fall having occupied a great space in the bed of the sea hath thrown the water very far into land: without any such suppositions, I say, there is no want of proofs, that the greatest part of the lands, which have been inhabited beyond all registers of time, were originally covered by the waters of the sea, which hath since by imperceptible degrees, and sometimes suddenly, deserted them.

The multitude of sea-fish-shells, that are found still intire almost in the center of mountains in Sicily and England, leave no room to doubt but those islands have been covered

covered with water; and we have no less proofs in France, that this part of Europe which we inhabit was formerly a bed of the sea.

About an hundred and fifty years ago, Bernard Palissy a Frenchman, without any other studies than his own observations made in several parts of the kingdom, began to insinuate this doctrine in public conferences, which he held at Paris in the reign of Henry the third.

I could add to his observations some more proofs, which I have been able to collect from the voyages I have made to every part of this kingdom in gathering simples.

I had the honour, some years ago, to present to the academy some true madrepores still adherent to their rocks, which I had pulled out of the earth at Chaumont, near Gisorre. They are stony plants that grow only at the bottom of the sea, and which are therefore the most certain marks one can have, that this part of the continent composed formerly the basin of the sea.

Now upon supposition that these places have been once covered with water, it is easy to comprehend that impetuous waves driven from north to south, and repelled from south to north, either by the resistance of high mountains or by violent hurricanes, have carried away with them the animals and plants of the southern countries, from whence the
the

the waves have been driven back; and that in this reflux the waters having glided *into* and remained *within* creeks and basons, formed by certain ranges of mountains, have *there* retained these light bodies, some intire, and others broken.

Thus we may conceive the foreign plants and shell-fish conveyed by the sea water very far into our lands on the continent.

Memoirs 1718, pag. 287.

N. B. *I must own that this method of conveying plants from the islands of America to the continent of Europe over such a vast expanse of sea, however pleasing to the imagination, which delights in what is marvellous, and however fitted to solve the difficulties on this subject, seems to me too bold and daring to be confined within the bounds of probability.*

I cannot help observing likewise that Mr. De Jussieu, at first diffident under what class to rank the plants with which these figured stones are marked, declaring it extremely difficult to characterise or even to give a description of them, yet all of a sudden pronounces them to be of American or Indian growth alone.

We find accounts in classical writers of plants and animals that were formerly the products of Greece and Italy, and are now no longer to be found in those countries: why may not the same thing have happened with regard to these plants,

plants, especially as we may be allowed to include a much greater compass of time for the making such a change?

I beg leave to remark also that the bare outlines of a plant, intersected by others, as Mr. De Jussieu acknowledges, must make it extremely precarious and uncertain to assign its family.

A large district of country overwhelmed by sand.

In the neighbourhood of St. Pol-de Leon in the Lower Bretagne there is a district along the sea shore, which before the year 1666 was inhabited; but is now no longer habitable on account of a sand that covers it to the depth of above 20 feet, and which from year to year advances itself and gains upon the land. It hath gained more than six leagues since the year 1666, and is at present no more than half a league from St. Pol, so that in all probability that town must be abandoned. In the country that is overwhelmed, there are still seen some tops of steeples and chimnies, which rise out of this sea of sand.

It is the east or north east wind that increases this calamity; these winds raise the sand, which is very fine, and carry it in such great quantities and with such swiftness, that Mr. Deslandes, to whom the academy is obliged for this account, says that in walking there, whilst the wind was sweeping it, he was obliged from time to time to shake his hat and clothes, because he felt them grow heavy.

heavy. We should remark by the way that there are in this sand a great number of iron particles, discoverable by a knife that hath been touched by the loadstone.

This unhappy district over-whelmed in so singular a manner, justifies what the ancients and moderns relate of tempests of sand, that have destroyed whole cities and armies.

History 1722, pag. 7.

On the 6th of April 1719, there fell in the Atlantic Ocean at 45 degrees of north latitude, and $322^{\circ} 45'$ of longitude, a storm of sand, which lasted from 10 o'clock at night to one o'clock in the afternoon of the next day. It was preceded by an *aurora borealis*; the wind was E. S. E. The captain of the ship, and all that were on board, have attested the fact to father Feüillée, to whom they gave some of the rain, if I may be allowed that expression, which was easy to be kept; he hath sent a small parcel of it to the academy: it is a common sand, and very fine. The nearest land to the place specified, is at 8 or 9 leagues distance. This cloud of sand must have been conveyed therefore all that way through the air.

A storm
of sand.

History 1719, pag. 23.

The thunder-bolt stones are real flints, that have the shape of a wedge or of an arrow-head. This figure occasioned the ancient Greeks

Of thun-
der-bolt
stones.

Greeks to imagine that they were the arms of the thundering Jupiter, and that he darted them from his hands together with the thunder. This opinion hath passed or sprung up of itself amongst the people of the north, who finding these stones in great abundance in their own countries, have no less revered them. They even believe these stones, although proceeding from thunder, to be a preservative against it; and it is with great difficulty that one can undeceive them even at present.

The Chinese are not much within the sphere of the contagion of these ideas, but yet have notions pretty much alike; and it is not easy to conceive how this superstition should be so natural.

The origin of these stones is very evident, and very certain, from observing the *like* cut and fashioned by the wild savages of America, in order to cleave wood, or to arm their arrows. They have no iron; but by rubbing stones very hard one against another, they make these sorts of tools, which are absolutely necessary to them, without grudging the time, of which they have indeed enough. Our continent was anciently inhabited by savages, and the same wants, the same scarcity of iron, inspired them with the same industry. Afterwards these tools, which were become useless, were buried in great quantities under ground, and have been preserved

there better than if they had been made of any metal, for the rust or verdigrease would perhaps have consumed or disfigured them. Thus have they *fallen*, or more properly *risen* into thunderbolts.

If the *figured stones* are monuments of great *natural* revolutions, *these* are a monument of a great *moral* revolution; and the comparing the new world with the ancient, serves equally to prove the changes that have been both in *man* and *nature*.

History 1723, *pag.* 16.

When a person hath been bitten by a dog that is apprehended to be mad, it commonly happens that the dog is killed before one is assured of his condition, and the person bitten continues in a cruel uncertainty. Mr. Petit the surgeon hath an expedient for putting an end to this uneasiness. He rubs the throat, the teeth, and the gums of the dead dog with a piece of meat that hath been dress'd, taking care that there may be no blood to stain it, and then offers it to a living dog. If he refuses it with crying and howling, the dead dog was certainly mad; but if the victuals have been well received and eaten, there is nothing to fear.

An useful
observa-
tion with
respect to
the mad
dog.

History 1723, *pag.* 29.

Observations of communicating the magnetic virtue to workmens tools.

In the shops of locksmiths, cutlers, and ironmongers, we find abundance of magnetic tools ; almost all those which these workmen make use of in cutting or piercing iron cold, as shears, punches, and broaches, take up filings of iron as soon as brought near them : there are even *some* that take up little nails, as well as they could do if they had been touched by a middling loadstone ; even files are often found magnetic. In a word *this* is peculiar to all tools that cut iron or steel.

However common this manner is of giving the magnetic virtue to steel, I do not know, says Mr. De Reaumur, that naturalists have hitherto examined it ; in general we study too much natural philosophy in our closets. This subject hath appeared to me to deserve attention, and insensibly engaged me to make divers experiments.

I began by examining whether the tools I have mentioned derive their property of attracting iron from the iron itself, which they have cut or pierced, or whether they owe it to the temper of the steel. I caused different sorts of tools to be made, and of different sizes in each sort ; I got them tempered, and tried immediately after the tempering whether they were in a condition of attracting filings. I did not find one to which the tempering had given this property, at least sensibly ; I saw *some* indeed that barely lifted up

a grain or two of the filings, but perhaps they would have done *so* still more before they were tempered.

Mr. Rohault relates, that having caused a long and slender piece of steel to be made red-hot, and having plunged it in water whilst he held it perpendicular to the horizon, he found at each of its ends the virtue of one of the poles of the loadstone, together with *that* of attracting very well the filings of iron. This experiment of Mr. Rohault engaged me to repeat it several times; but in vain have I plunged the steel in the circumstances he describes; I never found that the tempering gave it any sensible virtue of attracting; yet I doubt not but the piece of steel, of which Mr. Rohault speaks, had the property he hath attributed to it, but probably it was not the *tempering* which occasioned it. We shall discover presently some circumstances that might have produced it, which Mr. Rohault may be supposed not to attend to.

I lay it down for certain therefore, that steel tools, that have been but just tempered, have not yet the virtue of attracting iron; but one instant of time is sufficient to communicate *that virtue* to them. Take a chisel or a punch immediately after being tempered; place the edge of the one, or point of the other, on a piece of iron, no matter in what inclination; give a blow with the hammer at

the other end of the tool, you will find it sufficient to give the magnetic virtue to the point or edge: present the point or edge to some filings of iron, it will attract them, and become quite bristled with them. The having once cut iron is sufficient to give the tool the power of attraction: from the first blow however the virtue is still weak; it is increased by repeating the blow a second time; and repetitions for a number of times will still add to the new attractive force: but there is a limit, beyond which you would repeat in vain the operation, the virtue would be by no means increased by it. Those which have been made use of for several months, are no more vigorous with this power, than those which have been used but a day, nay even but an hour.

There are however divers circumstances which contribute to augment this force: first the shape of the tools is a material circumstance; a chisel, whose edge is flat, receives the attractive power less strongly than a punch whose point is conical. This may be remarked by comparing the effects of different tools, but I have made trial of it in a manner the least equivocal. I caused the edge of a chisel to be forged a second time, and to be changed into a conical point, by which it attracted much more strongly. It must be observed however, that *cæteris paribus*, the bigness of the tool contributes to increase its force.

Secondly,

Secondly, the most important circumstance in a tool is to have a certain length ; if it is extremely short it is scarce attractive at all. I caused some punches to be forged that were not above an inch long, and were 8 or 9 lines in diameter : they attracted only some few grains of filings after having pierced a great deal of iron ; whereas punches 3 or 4 inches long, and no more than a line, or a line and half in diameter, attracted little nails.

Whilst I was trying to what degree it was possible to give this attractive virtue to tools by making them cut or pierce iron, I happened to be near an anvil, on which I placed the little pieces of iron, that served to try the force of my magnetic tools. I put upon my hand one of the pieces that had been attracted on the anvil, and was surprised to find, that whilst it was on my hand, the magnetic tool had not the same power to raise the iron ; it could not even take up a piece that was much lighter than *those*.

I then placed the pieces, that I wanted to attract, upon other bodies, such as wood and paper, but the tool had no more hold of them *there* than when they were upon my hand ; yet as soon as they were replaced on the anvil, the tool took up the largest of the pieces with the same ease as before. The same experiment, repeated and varied afterwards abundance of ways, proved to me that the magnetic tool had more force to attract

iron when placed on other iron, than to attract the same iron when placed on other bodies.

Another remarkable thing is, that the attractive vigour of a tool increases in proportion as the piece of iron, that serves for a support to *that* you would attract, is bigger; what the magnetic tool hath raised from an anvil, it will not raise from a flat bar of iron. I have not been able to determine the exact proportion of the attractive force to the thickness of the support, but I have observed often that the iron, which was lifted from an anvil, weighed more than double of *that* which was lifted from an ordinary bar.

These experiments discover clearly a circulation of magnetic matter round iron; they force us to acknowledge that this metal, like the loadstone, hath an atmosphere, and conveys its virtue to other iron within its sphere. As the magnetic tool raises a much heavier weight, when it is near a large mass of iron, than when it is near a slight bar, the reason must be that the large mass hath an atmosphere that furnishes more of the magnetic matter.

I took a piece of very pliant iron, and screwed it in a vice between 4 and 5 inches from one of its ends; then taking with my two hands the longest end, which was above the vice, I bent it forwards and backwards several times in the same place; at last
it

it broke in that place ; but as it was very pliant, it did not break till it had suffered much torturing. As soon as it was broke, I presented both the broken ends to some filings of iron, and saw them immediately covered with the filings ; they would have attracted *less* from being touched with a weak loadstone.

It must be observed that, *cæteris paribus*, the more the iron is soft and pliable, the more it suffers itself to be tortured before it breaks, but then the more vigorously are the broken ends endued with attractive virtue. Plated iron and brittle iron attract less strongly ; but in general I never found any iron, whose broken ends would not attract at least some grains of filings, provided they are tried *the instant* they are broken. I add this last circumstance, because the attractive virtue grows weaker by degrees, and sometimes doth not last longer than a day.

It is above all essential that the piece of iron which is broken should have a certain length, without which you will find no sensible effect, as we have observed before with regard to tools. A single example will be sufficient on this head. Take a rod of iron about a foot long, break it pretty near the middle, and the two broken ends will attract very well the filings. If on the contrary you break such a rod at an inch or two from one of its ends, the broken end of the short piece

M 4

will

will not attract at all, whilst the end of the long piece will attract very vigorously.

It must be remarked that it is the broken end alone that attracts, the other is not in the least attractive.

I was willing to try if this virtue might not be increased by bending the iron rod forwards and backwards in different places, taken at divers distances from that end. For this purpose I chose a rod of iron, about the thickness of a little finger, and near two feet and half in length. After having screwed it in the vice, I bent it forwards and backwards several times in the same place, and at last broke it in that place, which was distant pretty near five inches from one of the extremities of the rod. By this division I had two pieces, the *one* about five inches long, and the *other* about two feet and an inch; both these pieces were extremely attractive at their broken ends, so as to be able to raise from the anvil one of those little nails called *tacks*. The longest of the two pieces I destined for pursuing my experiments; I screwed it in the vice about an inch and half above the attracting end; I then bent it forwards and backwards several times so as not to break it. After having taken it from the vice, I tried whether its attractive virtue was by this means increased, and it appeared to me that it was *so*. I repeated the same contrivance in order to be assured of this augmentation, and

to see how far it would go. I continued in like manner to bend it forwards and backwards in eight different places between the attracting end and the middle of the rod. After every torture given to each new place of the rod, I tried whether there was an increase in the attractive force; I was satisfied there had not been one torture which did not give a fresh vigour: but the effect of all those operations together, could admit of no doubt. They put the attracting end in a condition of raising four nails, equal each to *that* which it bore immediately after being broke.

Pursuing my experiments I bent the rod, at first towards the middle, afterwards between the middle and the non-attractive end. The effects that happened *then* will appear perhaps no less singular than the former. These new tortures that I gave to the rod, did not strengthen the attractive end; it seemed to me that they weakened it, and by repeated experiments I was convinced they did *so*. I tried immediately whether the *second* end had not gained what the *first* had lost, and I found in reality that the *second* end began to raise the filings, which it had never done in the least while the *first* was in its vigour. I continued to torment the rod in different places, approaching continually towards the second end, and I saw, in proportion as I multiplied these operations, that
its

its attractive force increased at the expence of *that* of the first end; it acquired enough force to raise the four nails that had been lifted by the first.

I was willing to see what would happen to a rod of iron that should be tormented at first in the middle, and afterwards at equal distances on the one side and the other from the middle. The flexures and reflexions made in the middle, and in places not far distant from *thence*, gave no sensible attractive virtue to the ends; but when I bent the iron at about a third or a quarter of the distance between the middle and each end, then the one and the other end became attractive, but much less strongly than if the flexures and reflexions had been of one side alone; they did not bear each a third or a quarter of what *one* of the ends would have borne, if the attractive virtue had been given to *it* singly.

As a little matter suffices to give iron the virtue of attracting, so a little matter is sufficient likewise to destroy it. If after having given a certain degree of this virtue, you would multiply the inflexions, although you make them between the middle and the attracting end, you only weaken the force of its virtue; you at last entirely destroy it by multiplying them to a certain point.

Strokes with a hammer upon a tool not resting on any other steel or iron, deprive it
of

of the virtue of attracting, which it had acquired by cutting or piercing iron : they take it away likewise from iron that derives that virtue from inflexions. Too many inflexions produce at length the same effect as strokes of the hammer. There is however a method of giving this magnetic virtue to iron by strokes of a hammer :

A large bar of iron struck hard in the middle, or near one of its edges, with a little hammer, acquires the attractive virtue at the opposite end, but yet less than the iron which hath been bent to and fro several times. This therefore is another method of giving the attractive power to iron without its touching a loadstone ; but it is one of the weakest.

In this weak manner of giving a magnetism to iron, there is however a circumstance that deserves to be remarked, which is that the whole end of the bar is not indued with magnetism, it never is *so* directly opposite to the places which have received the blows of the hammer. If the strokes have fallen only on an half of the breadth of the bar, it will be only that half of the end, which corresponds to the part not suffering percussions, that becomes attractive. If care hath been taken that the strokes should fall exactly in the middle of the breadth of the bar, it will be the middle part alone of the end of the bar that is destitute of the virtue.

We

We mentioned at the first that all tools which cut iron *cold* become attractive; we shall add at present that, on the contrary, all tools which cut iron *hot* have not any attractive virtue. Moreover this virtue is destroyed in a magnetic tool, if it is made to cut iron red-hot from the fire.

I thought it necessary to try whether these same tools would not become attractive by cutting *other bodies* of different degrees of hardness: I tried shears that had cut a great deal of wood, others that had cut copper, and others that had cut stones harder than iron, upon filings of iron. I found in them all some small degrees of attractive virtue, weaker however in such as had only cut wood, than in those which had cut copper.

If I am asked how it comes to pass that iron, with this abundance of magnetic matter, doth not produce the effects of the loadstone? I answer because it wants such *determinate poles* as those of the loadstone; it is from its poles that the loadstone derives its force. I conceive iron to be a kind of jumbled loadstone, or to resemble a mass of the powder of loadstone, in a word, that iron hath almost *every where* imperceptible poles. From thence it is easy to conceive that, altho' there may be round this metal and within it a great circulation of magnetic matter, yet it cannot have any great attractive power, because

cause the streams of magnetic virtue do not concur towards the same place.

Memoirs 1723, pag. 82.

N. B. *I have given the experiments and observations of Mr. De Reaumur divested of the theory, with which they are enveloped. This theory consists in an imaginary notion of magnetic vortices, which he impels, directs, and diverts, just as it will suit the several phenomena of his experiments. An hypothesis like this, altho' ingeniously forged, and pliable as the iron rods in his own experiments, doth not fall within the compass of my design, which is to exhibit nature, and not to transcribe romances.*

Mr. Carré read a letter he had received from Holland, wherein mention was made of a loadstone, which weighs 11 ounces and raises 28 pounds of iron, that is to say, more than 40 times its own weight. It was to be sold for 5000 livres.

A remarkable loadstone.

History 1702, pag. 18.

It hath hitherto been thought that water alone dilates or increases in bulk by freezing, but Mr. De Reaumur hath discovered the same property in iron, which being melted expands itself in proportion as it cools and returns to a consistence: the other metals on the

A new discovered property in iron.

the contrary follow the general law of losing something of their dimensions in proportion as they grow cold. A consequence of this property in iron is, that iron is capable of being cast in a mould in greater perfection than any other metal. The reason is evident, because iron extending itself as it grows cold, will by consequence insinuate itself and be applied to the least and finest strokes in the mould with all the force of its extension, and must therefore receive very lively the impressions: whereas the contrary will happen in metals that contract themselves, and withdraw continually from the finest strokes of the mould, to which they were at the first instant applied. It is true indeed that iron is very rarely or scarce ever rendered so liquid as gold, silver, copper, tin, and lead. Notwithstanding this disadvantage cast works in iron have a remarkable neatness and vivacity beyond those of other metals.

A property so singular cannot be granted to iron without being proved in an incontestable manner. Now the point to be demonstrated is this, that iron at the time the fire keeps it in fusion is heavier than when it hath its ordinary hardness. In order to prove this I made a very fluid fusion, and when it was *such* I carefully skimmed the surface that there might not remain any film that could oppose the success of the experiment. Into this fluid fusion of iron I threw some pieces of

a solid cast iron: if the liquid fusion is heavier, hath less bulk than the solid cast iron, it is certain that the latter must necessarily swim on the surface of the other, and rise a little above it, as ice swims on the surface of water. Now this actually happened, in vain did I force down the pieces in the liquor, I saw them appear again and rise a little above the surface.

I have likewise poured this metal *melted* into little cylindrical crucibles, which I exactly filled, taking care that I barely filled them by passing a plate of iron over the brims. I then left the liquor to congeal by degrees; the metal when it was become perfectly solid had risen above the edges of the crucibles, and taken a convex surface, like to that of water which is frozen in vessels.

When a fact is once known and ascertained, one finds every moment proofs of it that were unheeded before. The greatest part of moulds are composed of two frames that in general the founders squeeze in a press. After casting the iron into the moulds, particularly when the work was thick, I have often observed that it was with great difficulty the founders were able to turn the nuts of the press; they used to be surprized at this, because no such thing happens to moulds that have been filled with copper.

The reason now appears evident, iron could not dilate itself without constraining the
mould

mould against the press, much more than it was before the metal was cast in.

We shall add a remark which is a consequence of the preceding observation. *Cast* works of lead, copper, gold and silver, are always found *less* than the models upon which they have been framed. The *like* works of iron are on the contrary *equal* to their models, or even exceed them something.

Mr. De Reaumur made experiments likewise on zink, bismuth, and antimony, and found that bismuth and antimony must be ranked, with regard to this property, with iron and water.

Memoirs 1726, pag. 273.

Of the
specific
differences
of earths.

It is not the elementary earth of Aristotle and of many others, but an earth more known and familiar to us, that is the subject of our present enquiry. It would be a thing extremely desirable, to acquire very distinct ideas of *first principles*; our knowledge would be more complete by it; but yet tho' we were possessed of such knowledge, we ought not to have recourse to it in order to determine the nature of the greatest part of bodies that are the objects of our researches. To explain my meaning more clearly, I shall make use of a comparison, somewhat ignoble indeed, but which seems to me very proper to shew, that we take a wrong method of instructing ourselves when we pass of a sudden

den to *remote* principles: this is unhappily the fault of chemistry, to which we owe however so many fine discoveries in natural philosophy; it rarely shews us the *immediate* elements.

Let me bring from America or the Indies some one, whose passion hath always been natural philosophy. I suppose him well versed in all the processes of chemistry, but very ignorant with respect to every thing that hath been contrived in Europe for flattering the taste. I carry him to a pastry-cook's, where I shew him cakes of all kinds, biscuits, and all sorts of tarts that are the workmanship of this art. I ask of him what each of these compounds hath peculiar, what is their nature? If in order to answer my question he hath recourse to analysing them, to distillations, and cohobations, &c. he may tell me that in such cakes there are more oily parts, that others have more of salts, others again more of acids; he may even determine the proportion there is between the earthy parts, the sulphurs, and the salts. But will he have given me any more an idea of the compositions, on which I have consulted him, than of *those* of some stones or plants, which treated in like manner would have given pretty much the like principles?

The true answer to my question is, that such a cake was made of nothing but common water, flour, and butter; that eggs are

in the composition of another; that yeast is used in this, sugar in that, and pounded almonds in a third. Lastly, it would be necessary to tell me that according to the manner in which the butter is mixed with the flour, it is made a puff-paste or otherwise. If the pastry-cook shews our philosopher the materials that are employed and the manner they are employed in, he will see that he was to blame in having recourse to quintessences, in order to discover the nature of these compositions.

When nature works in forming cakes of another kind, such as stones, metals, and minerals, she hath not always quintessences to employ, she makes use of sands, sulphurs, bitumens, such as she finds. To introduce bitumens and sulphurs into her works, she no more analyses them than the pastry-cook analyses his butter. In a word, it is with compounds that she forms the greatest part of the bodies, which are the objects of our consideration.

In conformity to this manner of philosophizing, Mr. De Reaumur hath examined *earth*, and finds by plain and certain experiments, that *earth* sucks in water in such manner as to be increased in bulk, and reciprocally returns to its first size when it is become dry. *Sand* soaked with water as much as it is possible to be, doth not increase in bulk, nor diminish *ought* by growing dry.

From

From whence it follows evidently that water only fills the interstices of the grains of sand, but besides this function in earth it penetrates more deeply into the grains, swells, and dilates them. Mere penetration, either into the interstices, or into the cavities of the grains of earth, requires only weight, mobility, and fineness of particles in the water, but the *distension* of the grains requires indispensibly some other force to make more water enter violently into the grains than they would naturally admit, and to surmount their resistance to this distension. What is this force? It would be difficult to give a satisfactory answer; but it is undoubtedly the same as that which makes cords, that have imbibed water, when they come to contract themselves from their distended state, to raise enormous weights. It is that which makes wedges of dry wood, forcibly impelled into a rock, to cleave it asunder, and detach from it large mill-stones, when they are distended with the water that they are made to suck up.

Sand, however finely pounded, is not the more open to water, it lets none enter but into the interstices of its grains; and if it doth admit *some* perhaps into their little cavities, yet the water doth not extend them, since the total bulk of the sand receives neither increase by the introduction of the water, nor diminution by its drying. It will happen sometimes that the surface of the sand will

even sink a little by wetting, because the water that hath penetrated may have changed the place of some grains of sand and have carried them into spaces, which, tho' capable of lodging grains, had continued empty. *Earth* therefore is a sort of spongy body, the particles of which are flexible and capable of extension; those of *sand* on the contrary are incapable of it by their stiffness.

Earth and sand differ in another respect no less marked nor less decisive. Earth soaked with water becomes ductile, it takes any form you have a mind to give it, as we see every day in the art of potters-ware: this quality corresponds to malleability in metals, and is probably owing to the same cause.

Now this property is not to be found in sand, its parts are too stiff and too inflexible; and no doubt *this* is occasioned by what we have already observed that it is not spongy like earth.

The more greasy the earth is, the more ductile it will be: It is more or less greasy either of itself by the more or less of a certain unctuousness it contains, or by the different quantity of sand with which it is mixed.

It might be thought that the ductility which is found in earth and not in sand arises from *hence*, that the grains of earth are finer, as they commonly appear; it is certain indeed that fineness contributes to ductility, which consists in *this*, that the small parts slide easily
one

one upon another without losing their connexion, or in taking new connexions: but Mr. De Reaumur hath made experiments which intirely destroy this notion.

With earth mixed with sand, as it always is, and a sufficient quantity of water, let there be made a muddy water, and leave it to settle in a vessel; the grosser sand will sink to the bottom at a certain time. By this operation, repeated in different successive lotions, you will have the sand and earth as separate and pure as it is possible to be; the earth keeping suspended whilst the heavier sand precipitates to the bottom. Pound this sand extremely fine, reduce likewise to powder the pure earth, and you will find that these two powders mixt together and put in water will be equally suspended. It follows therefore that the particles of the one and the other are of a sufficient fineness to receive from the water an equal resistance to their descent. Strictly speaking we must allow a greater fineness in the particles of sand than in those of earth, as they are specifically heavier and would descend if they had not a larger surface in proportion to their greater weight; now for *them* to have a greater surface in proportion to their weight, they must necessarily be much smaller, as geometricians well know. Yet a paste made of this same powder of sand will not be *ductile*, altho' one made of the powder of earth will really be *so*. The duc-

tility of earth therefore arises from a more intrinsic quality than the fineness of its grains, and by consequence is proper to be a specific character, to distinguish earth from sand.

The spunginess of earth may be the cause of its ductility; its grains not only penetrated and softened by the water but swelled and extended, stretch themselves out to clasp one the other, easily take on account of their suppleness the figures necessary to be adjusted well together, and are for the same reason in a condition of changing easily those figures in order to assume others. When earth, of which a paste hath been made by soaking it with water, becomes dry, it will be more hard and compact, because the new joinings of the particles, which the water hath produced, still subsist even after evaporation. It is clear that the contrary must happen with regard to sand.

From what we have observed with regard to earth, that it imbibes and is distended by water, we may likewise solve that well known and useful property of clay in holding water, so as not to let it pass through. To this property we are indebted for so many springs and wells, which retain water for our uses. A water that comes upon a dry clay finds grains ready to receive it, it may then find passages likewise between the grains, which permit it to advance to a certain depth. But immediately it hastens to stop up the passages again.

against itself. In proportion as it sinks into the grains, it distends them, and forces them to be united more firm and compact together. Rohault, who probably did not attend enough to that property of earth, which we have been mentioning, attributes this effect to another cause, that seems at first view to be sufficient. He imagines that water which penetrates clay, carries along with it the finest grains, that it deposits them in the passages, and thus by little and little stops them up. But this notion is confuted by the following observation. If a piece of dry clay be wetted by the vapour alone of a moist air, it would be difficult to conceive that in this case there were any displacings and removals of the grains of earth; yet clay *thus* moistened would be capable of containing water, as well as *that* which hath been watered with a considerable quantity of that fluid.

This property in earth of expanding itself by moisture and contracting by dryness is necessary to be attended to by the potter, whose vessels are apt to crack in drying; by the gardener in raising his terrasses; and by the engineer in making his ramparts and bulwarks, particularly with respect to the pressure it occasions against the lining wall.

Mr. De Reaumur observes several other differences that distinguish earths one from another. They differ with regard to colours, whether such as they have naturally or such

as they receive from the action of fire. Painters know how great the variety of colours is in earths, and it is a knowledge extremely useful to them. Some earths vitrify, others are calcined; and this likewise in different degrees. They are all considered as alkalines, and indeed acids act on them, but very differently. There are earths that receive from the weakest acids a violent impression, whilst others scarce receive any sensible effect from the strongest.

There is another quality of earths that hath not been attended to, which is their *smell*. *That* which rises after rain in the summer is well known; it comes from earth that hath scarce any smell but when it is wetted; and in this respect is the direct contrary to some other substances, such as hair, horn, &c. which have a smell only from *burning*. The odours of different earths have differences from each other, like those of flowers; and it is in like manner difficult and often impossible to characterise them. As it is the rose alone that can convey the idea of its smell, so the odours of different earths can be known only by applying to them. Their smells in general are so many particular smells, yet there are some which have a resemblance to other smells; for example there are earths whose odour approaches very near to *that* of pepper.

The smell after rain is commonly attributed to the plants of woods or gardens where one chances to be walking. But if it be remarked that the most *arid* fields, and such as are covered only with dry stubble or plants as dry, diffuse at that time the like smell, it must be acknowledged that the earth alone is the source of that odour. It must be observed further, that the atmosphere of the smells of earth is not very extensive, the nose must be pretty near, or it will not be perceived; which is another proof that it doth not arise from plants. I was willing to see if it was possible to exhaust this odour from earth. I watered and dried successively little cakes of earth for more than a fortnight several times in a day: at the *last* of my experiments I did not perceive that any of my cakes gave a less odour, than at the *first*.

History 1730, pag. 24. *Memoirs* pag. 243.

We naturally interest ourselves in the actions of animals that live in society. Without being observers of nature, we love to hear of the good understanding amongst *beavers*, who work by concert in building houses of earth and wood, several stories high, in order to defend themselves from inundations. The republics of *ants* and *bees* have gained esteem and admiration through all ages. Societies are perhaps the first and most beautiful contrivance of human reason: we are surprized to

Of wasps.
by M. De
Reaumur.

to find that animals, which we despised, imitate us in this essential point ; and after having vainly imagined ourselves the only creatures indued with skill and foresight, we are almost inclined to grant in some insects a greater sagacity than in ourselves.

The *bees* are a pacific people that labour for our good, and in return we interest ourselves for them ; other insects make war upon them, and consequently excite our enmity and abhorrence : they have no enemies more dreaded than the wasps, who are not content with plundering them, but likewise devour them. The wasps, compared with the mild and well-policed republic of bees, appear to us a savage nation, a kind of hot-tentots ; but we judge thus ill of them only for want of knowing them. We may apply to wasps, what hath been often observed with respect to a *distant* people, who have been thought *barbarians*, and are afterwards found to exceed *us* in many things. The republics of wasps are in nothing inferior to those of bees ; altho' more warlike, they are not less industrious nor less laborious. In short, they are with respect to bees, what the ancient Spartans were with respect to the Athenians.

I shall not enter into a detail of the several species of wasps, that naturalists make mention of, but shall confine myself to the description of their manners, to the discovery
of

of their industry, and to relating the methods by which they people and govern their states: I shall therefore say nothing of those species that live recluse like hermits. The object of my enquiry shall be only such as live in society, such as form with toil and industry a sort of cakes, composed of hexagonal cells like those of bees, but made of materials very different from wax.

These heaps of cells are principally destined to lodge eggs and embryos till they are able to take flight. We give the name of a wasp-nest to *these* cakes, including under that term all that the wasps build round about the cakes. We shall content ourselves with *distinguishing* these insects into three classes; and *that*, with respect to the places they chuse for building their nests. Those of the first class attach themselves to plants and branches of trees. There are several species of this kind, which are all of the smallest size, and compose likewise no very numerous states. The wasps of the second class commonly place their nest under a covert; they build it either in the hollows of trees, or in granaries that are little frequented. These are the largest of all, we call them hornets. Lastly, those of the third class build only under ground; they are not so big as the hornets, but are sometimes bigger than those of the first class; they are the most common of all in the kingdom, and assembled in the greatest

greatest number ; several thousands of *these* live together in society.

The wasps of all these classes resemble each other in their contrivances ; they work all their nests pretty much with the same art ; their occupations are nearly the same within their nests ; so that I shall give only the history of *those* of the third class *in detail*, and shall barely mention the others as occasion offers itself of taking notice of any thing particular. In order to make them known, it is sufficient to observe that they are *those* of the third class, against whom we have so much difficulty to preserve our fruits, particularly the muscadine.

These wasps that build under ground, are not only greedy of fruits, but must be ranked amongst the most carnivorous insects ; they make cruel war upon all other flies ; what they catch by chasing is not sufficient for them ; you find them in great numbers in butchers shops in the country. After having satiated themselves *there* with meat, they cut off sometimes pieces bigger than the half of their body, and carry them to the nest. On each side of the mouth they have a talon, or, if you will, a long moveable tooth ; the extremities of these two teeth or talons are dented like a saw ; it is with these teeth that they cut off pieces of meat, which they gnaw all round and underneath till the slice holds no longer by any thing : they are employed
on

on it with so much eagerness, that it would be easy to kill them even with the hand, without any risk of being stung, and to destroy in that manner a great number of them every day. Notwithstanding their robberies, the butchers in the country live in tolerable peace with them: I have a butcher at Charrenton that does more, he even makes their robbery turn to his account. They are particularly fond of a calf's liver, he therefore allots them one every day towards the end of summer, or sometimes only the milt of an ox; they attach themselves to this food by choice, and will touch no other meat: whether it is that *these* are more to their taste, or whether, being more tender and less fibrous, they are more easily cut? It is not however merely to hinder them from touching other meats, that he abandons to them *these*; another reason, of œconomy, induces him to it. Flies, and particularly the large black flies, deposite their young upon meats, which causes their corruption much faster. Now the wasps defend the meat from these large flies; they dare not remain in the shop, there is no safety for them, they are pursued by the wasps; and it costs the butcher no more for the defence of his shop, than the milt of an ox, or at the most the liver of a calf each day.

When they are satiated, and loaded with plunder, they return to their nest. The first
gate

gate that conducts into it, is an hole about an inch in diameter, the opening into which is on the surface of the ground ; the edges of the hole are turned up like the burrows of a rabbit warren, but the earth round about it is covered with grafs. This hole is a kind of gallery that the wasps have undermined ; it seldom goes in a straight line, but in windings and turnings ; the passage is not always of the same length, because the nest is sometimes nearer, sometimes further from the surface of the earth. I have never found any nest, whose highest part was not at least half a foot, but I have found several, that have been more than a foot, or a foot and half distant from the surface.

This hole is the passage that leads to a little subterraneous town, which is not built indeed in our taste, but yet hath its symmetry ; the streets and apartments are regularly disposed ; it is even surrounded by *walls* on all sides : I do not give this name to the sides of the hollow where the nest is situated, but the walls I speak of are in reality only paper walls, yet strong enough for the uses to which they are destined ; they are sometimes more than an inch and half thick.

These walls, or, to speak less metaphorically, this external covering of the wasp-nest hath different figures and sizes, according to the figure and size that the wasps have given to the works, which it includes. Commonly the

the external figure of the nest resembles a bowl or a spheroid, whose least diameter is sometimes horisontal, and sometimes vertical. I have found some nests that had the figure of a cone flatted, and somewhat narrower towards the base. This cone was between 15 and 16 inches high, and was about a foot in diameter near its basis: the diameter of those which resemble a bowl, is commonly between 13 and 14 inches.

I have said that the external covering is a sort of paper; I know no substance which it resembles more, tho' it differs a little from our paper; its predominant colour is an ash-grey, with divers shadowings; sometimes it inclines very much to a white, and sometimes to a brown or yellowish: these colours are irregularly varied by bands or streaks about a line broad, which gives a very remarkable colour to the whole outside of the nest, and makes a sort of *marbling*.

But what renders it still more singular, is the arrangement of the different pieces, of which this covering is composed; we have compared it to bowls and to cones, but we did not design to convey an idea that it had the *polish* of bowls: on the contrary, its surface is extremely rough; at the first view you would take it for a rock made of icicles. We shall describe it more particularly in speaking of the manner of its structure.

Each

Each nest hath two round holes, by the one of which the wasps constantly enter, and come forth by the other ; each hole can let but one wasp pass at a time ; altho' the holes are narrow, by means of this *regulation* the motion of the wasps is never retarded.

Vid. fig.
plate 4.

We are yet only arrived at the gates, we will now enter into an examination of the inside of the nest. It is occupied by several flat cakes, parallel to each other, and all placed nearly horisontal. They resemble the cakes or honey-combs of bees in *this*, that they are every one an heap of hexagonal cells, very regularly built ; but they differ from the honey-comb in many circumstances ; *they* are made of the same materials as the external covering of the nest, that is to say, of a sort of paper ; *whereas* the cakes of bees are composed of *two* ranges of cells, of which some have their openings on one of the faces of the cake, and others open on the other face ; *those* of the wasps have only a *single* range of cells, and *all* have their openings at the same place, namely at the bottom. *These* cells contain neither wax nor honey, they are destined only for lodging eggs, for the worms that are hatched from them, and for the young wasps that have not yet taken flight ; *whereas* the worms that are the offspring of bees lie almost horisontal ; *those* of wasps stand almost direct, with their head downwards, because they have it always turned towards

towards the opening of the cell. The thickness of the cakes is pretty near equal to the depth of the cells, and proportionate to the length of the flies.

All wasp-nests do not contain an equal number of cakes; I have found in some to the number of 15, and in others no more than 11; the diameter of the cakes varies in the same proportion as *that* of the covering. The first, the uppermost of the cakes hath often no more than *two inches*, whilst those of the middle have *a foot*, in diameter; they are likewise smaller than those of the middle.

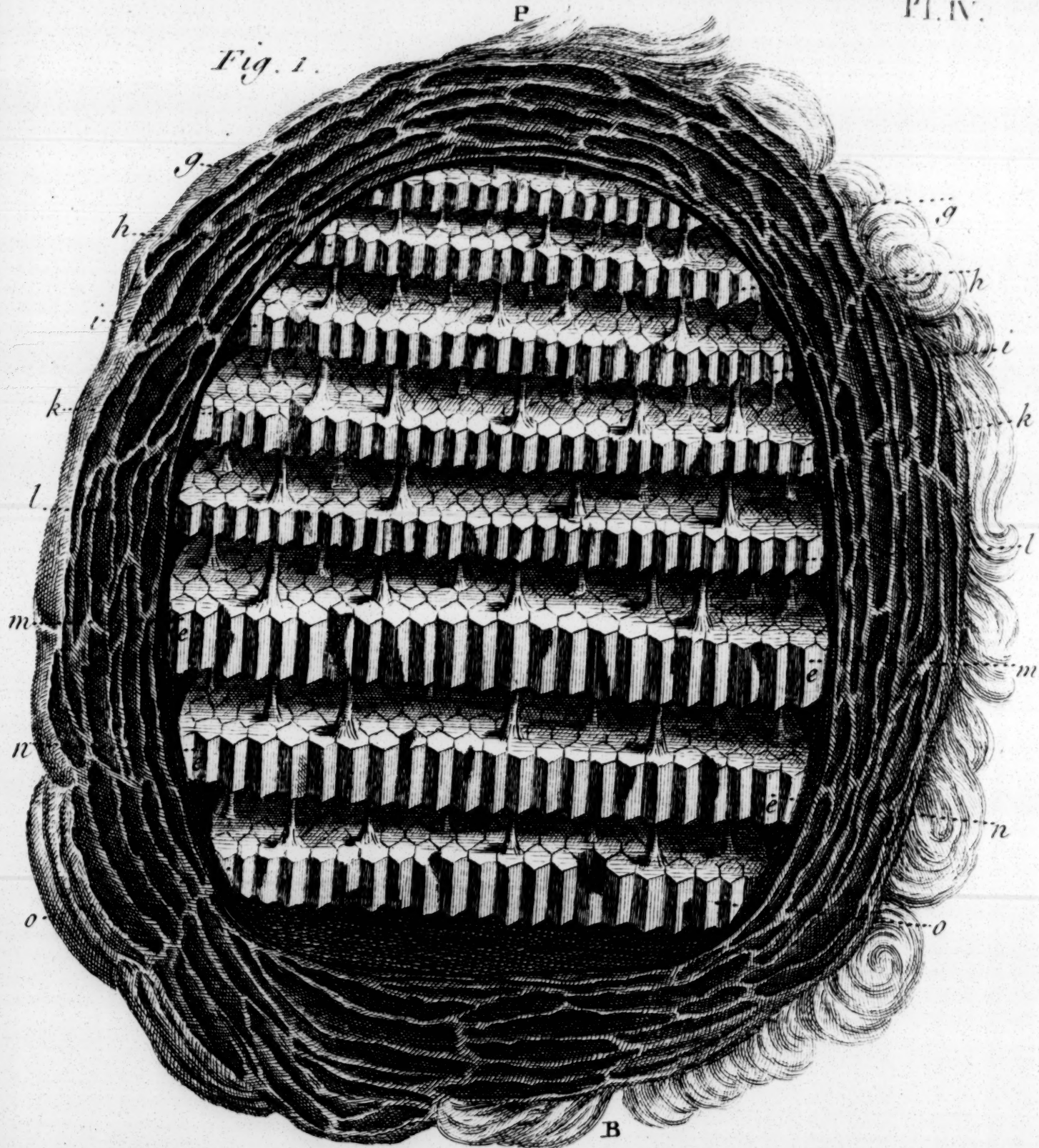
All these cakes are disposed like so many floors, or stories, which furnish lodgment to a prodigious number of inhabitants; we may make a gross calculation of them. Instead of 15 cakes, *un-equal* in diameter, let us suppose that they are every one 8 *inches* in diameter; or, to make a more commodious calculation, let us suppose these cakes to be squares whose sides are 8 inches. I do not believe that I have been too favourable to our calculation. I have found that 7 cells ranged in a row took up no more than the length of an inch and half. By consequence in an inch and half square there are 49 cells; now if an inch and half square give 49 cells, 49 inches square, which are the surface of one of our cakes, will give about 1067 cells; therefore our 15 cakes will have about 16005 cells. Indeed there is something to be bated in this

sum on account of the inequality of the cells, which we shall mention hereafter. But tho' we should allow only room for ten thousand flies, it would be sufficient to give an idea of the numerous people of these little republics; particularly when it shall be seen that there is not perhaps a cell that one with another doth not serve to produce three young wasps. Thus a wasp-nest breeds in a year more than 30,000 wasps.

The different *floors* or cakes, leave between them a free passage for the wasps; there is always between one and another half an inch distance, yet *this* doth not make very lofty stories, but their height is proportionate to *that* of the inhabitants. They are all suspended in such manner that the *first* bears almost the whole weight of the others; it is fastened to the roof of the wasp-nest, the *second* is fastened to the first, the *third* to the second, and so on successively to the last. They are *thus* connected together by a sort of *little columns*, consisting of the same materials as the cakes and the rest of the nest; the architecture of these columns is indeed very *plain*, they are barely round, their bases and chapters however have a larger diameter than the rest; by the *one* they are connected to the inferior cake, by the *other* to the superior. They have towards the middle scarce more than a line in diameter, but at the base and chapter more than two lines. There is therefore

Fig. 1.

P



therefore between every two cakes a sort of rustic colonnade, for the great cakes are suspended by more than fifty such columns. The cakes are fastened likewise in some places to the borders of the wasp-nest, which consequently lightens the weight of each superior cake.

Hitherto we have only given a general idea of the edifice; we shall now shew how the wasps build it, of what use it is to them, on what they are employed in the inside, in a word, we are to pry into the whole government of this little people. But these are state-mysteries that pass under ground, they are not to be penetrated into, if the wasps are left in their natural habitations. I have attempted to draw them from *thence*; I have tried to put them more within reach of observation, and have succeeded so far as to lodge them in glass hives, such as the curious make use of for bees. *There* I have at leisure seen all their little contrivances, and have shewn them to such persons as have visited me at my country house.

It doth not seem easy to transplant the lodging of such un-tractable insects; but the love they bear their young hath gained me success. If there be any case wherein natural history exposes a man to hazards, *this* surely is one. You must brave the stings of several thousands of wasps, that on all sides attack you on attempting to disturb them.

The wounds they inflict are not indeed mortal, but are extremely painful.

With an undaunted spirit of philosophical heroism, Mr. De Reaumur encountered these difficulties, and dislodged a nest together with all the earth that naturally environs it. I ordered a servant, says he, whom I had disciplined and armed cap-à-pe for these wars, to cut up a large clod of earth, in the middle of which was incamped a nest. After having conveyed the whole clod into my garden, I pierced it in different places in order to procure peep-holes for seeing what passed about the nest; but I found afterwards that it was of no use to take away their nest *upon a clod*; the love these insects have for their nests or rather for their young is inconceivable; whatever disorder and confusion is made in their nests, altho' it be broken and almost torn in pieces, they never abandon it, but follow it every where; it is full of young wasps that require their care and nursing; insomuch that in order to have an hive, wherein a wasp-nest hath been put, well peopled, you need only give these flies sufficient time for returning to their nest, and for that purpose wait only till the evening before you transplant it, otherwise you lose those that were out in the country. Those that happen to be abroad when a nest is transplanted, at their return to their hole finding no more their companions nor nest, know not which way to go, but
continue

continue several days about the hole before they determine to quit it.

After they have been put in the hive they begin with working to repair the disorders of their nests. They remove with wonderful activity all the earth and filth that may have fallen into the hive; afterwards they take care to fasten their nest firmly to the sides of the hive where it has been placed; they work at repairing the breaches; are employed in making it stronger, and increase considerably the thickness of the external covering.

This cover of the wasp-nest is a work particular to these flies; bees do not cover *their* cakes or combs. We have already mentioned that this cover is more than an inch and half thick: it is not of a massy thickness, but composed of several vaulted strata that leave vacuities between them. In proportion as the wasps thicken this cover, they build on the strata already formed another stratum composed of the like vaulted pieces.

The cover is a kind of box, that seems made for including the cakes and sheltering them from the rain which penetrates sometimes through the ground. It is proper for this purpose, altho' it consists only of a sort of paper, by means of the architecture we have been mentioning: had it been intirely massive, it would have been more easily soaked through. By being *arched* the water that hath penetrated through *one* arch can only

wet *that* underneath by droppings, whereas if the whole was massy the water would pervade by contact alone: besides, this sort of architecture saves a great number of materials. Nothing is more amusing than to see them work at enlarging or thickening this cover. There is no work that they carry on with greater dispatch; a great number of wasps are employed on it, but the whole is performed without any confusion. They fetch the materials necessary from the country round about; the wasp, that collects them, *herself* employs them on the work; the builder or mason-wasp (for others have other employs which we shall mention presently) returns loaded with a *little ball*, which she holds between those two talons, that we have said she makes use of for cutting off pieces of meat. This ball is the *matter* prepared for the work; the wasp being arrived at the nest carries it to the place she would enlarge; the ball is soft as paste; she fastens herself to the part on which she hath applied and pressed her little ball. Immediately afterwards you see the wasp retiring backward, and as she moves she leaves a *portion* of her ball, but not detached from the rest, which she holds between her two fore legs. Imagine to yourself a paste that is ropy, or a piece of soft clay, that you would add round the brim of an earthen vessel, and you will form an idea of the manner in which the wasp labours. Her two
talons

talons act as the thumb and finger of the potter would do, in pasting new earth to the brims of the vessel, in drawing it out, and flattening it down.

This new *rim* (*perhaps the Latin word fascia will more fully convey the meaning of the French term bande*) that hath been applied is yet too gross and unpolished; her next work is to make it thin and smooth; she goes without the least loss of time, and resumes her task *where* she first begun. This second labour is pretty much the same *in the manner of working* as the former. Her talons by patting the soft matter extend it; she goes over the work in this manner 4 or 5 times till she hath reduced the additional part to the thinness of the rest, or to *that* of a leaf of paper. It must be observed that it is with extreme quickness that the wasp labours, and always retiring backward; by this means she is in a condition of judging continually whether her work is good: the motion of her talons is much quicker than *that* of her legs, Each *rim* or *leaf* is about a line in breadth, and are *all* of different colours; which is owing to the different coloured materials, of which they have been composed. This I was convinced of by the following expedient: With a stick smeared at the end with glue I took out of the hive whatever wasp I had a mind for; those that I took, loaded with a *ball*, never quitted it notwithstanding the violence

lence that I did them ; they would still preserve the fruit of their labour. Amongst these *balls* some were white, others yellowish, and others blackish.

We are now to examine the composition of these *balls*. There is nothing in the whole history of these insects that was longer concealed from me. In vain had I observed wasps on all occasions when I could suspect that they were going to collect materials, I could never succeed in surprising them at the time they were loading themselves. Bees that gather their wax and honey on flowers, even wasps themselves, that settle on plants and trees in order to suck the juice of the leaves or what exsudes from the stems, had thrown me wide of the mark ; I thought to find them on such plants tearing up fibres for forming their paper. After a fruitless search and *when* I no longer pursued my enquiries on this insect, a mother wasp, of the subterraneous kind, came to inform me of what I had sought so often in vain. She placed herself near me on the frame of my window that was open. I saw her continue at rest in a place, from *whence* I could not imagine she could draw any thing very succulent. Whilst the rest of her body was *still*, I remarked divers motions of her head. It immediately came into my thoughts that the wasp detached from the *frame* materials for building, and the notion proved true. I observed her with
attention ;

attention; she seemed to nibble the wood, her two talons acted with extreme agility in cutting off fine pieces. She did not swallow what she detached, but added it to a little heap of the same materials which she had already collected between her legs. In a little time she changed her place, but still continued nibbling. I afterwards caught the wasp whilst she was busy on this work; I found her loaded with pretty near such a quantity of materials as they are wont to carry to their nest; she had not however *yet* formed it into a ball. The matter was not moistened so much as it is when the insect cements it to her work.

I examined this heap of filaments, which in all respects, except *that* of not being yet well moistened, resembled the balls which I had taken from wasps employed on building. These filaments appeared however very different from what one would expect the insect to detach from wood by nibbling. One would imagine that they should resemble saw-dust, that each bit should be pretty near as wide as long; each filament on the contrary was extremely small, altho' it had *at least* a line in length; there were even *some* much longer. Big and short pieces of wood, like *those* of saw-dust, would not suit our subterraneous wasps; *they* could not well be interwove for making a fine paper, it is necessary to have a sort of threads like to *those* of the paper

per which we make use of: and in getting *such* we must take notice of the great sagacity of the wasp. She doth not merely hash the wood, which would only give her little short pieces like *those* of saw-dust; but before she cuts it she makes, as I may say, a sort of scraped lint; she presses the fibres between her talons, raises them up, and by that means separates them one from another; having done *this* she afterwards cuts them.

I learnt this cunning of the wasp, not only from observation, but was assured of it likewise by detaching myself the fibres of wood with a penknife. I rubbed *at first* the wood lightly with the blade of the penknife in order to separate the fibres one from another, and I rubbed it *afterwards* more strongly in order to detach them. I collected in this manner filaments, which I compared with *those* that the wasp had collected, and could observe no difference between them.

Ever since I observed the wasp detaching wood from my window, I have been attentive to observe the actions of *those* that settled upon dry wood, and have remarked that wasps of all sorts go *thither* to cut filaments necessary for making their paper. I have seen them particularly attach themselves to the supporters of espaliers, to the frames and shutters of windows. But it is to be observed that they attach themselves only to old and dry wood, which hath been a long time exposed to the injuries

injuries of the air. It would not be easy to *draw* the fibres of *flax* fresh pulled; in order to draw them it is left to *steep* for a certain time; that is to say, it is kept soaking in water for several weeks, and afterwards is dried. The first surface of the wood, that hath been exposed several years to the injuries of the air, has been so often watered by rain, that it is in the condition of flax that hath been steeped. The cakes, and columns, that support them, are made of the same materials. The wasps likewise work the *cells*, that compose the cakes, in the same manner as the *strata* that form the cover; but the texture of the cells is more *loose* and resembling net-work; on the contrary, the texture of the columns is more *close* and compact. These columns are intirely massive, it is necessary that they should be much stronger than the rest. The wasps *do* them *over* sometimes with a sort of varnish, they rub them with their mouth, the places rubbed appear shining and always continue *so*. This varnish is perhaps the glue that binds together the threads of which their paper is composed.

N. B. *I cannot help observing that the artifice of the wasp in making paper gives great light into the manner, in which the ancients made their paper of the Egyptian papyrus. They might indeed have made it in much greater perfection, had they more carefully*

carefully observed and been instructed by the wasp; for Pliny in describing the method of making it says, præparantur ex eo (scilicet papyro) chartæ diviso acu in prætenues sed quàm latissimas philuras. Mr. De Reaumur hath remarked the great sagacity of the wasp in avoiding that error, and the reason on which her practice is founded.

The cells of the cakes are hexagonal: but I know not whether this figure enters into the design of their architecture, or is owing to the young wasps pressing the cells and making them take this figure. This is certain, that the outward cells have the half of their circumference *round*.

A great part of the wasps which we ranked in the first class, of those that build their nest on plants or on branches of trees, give their nest no covering at all. Their cakes are *bare* and their position is vertical. The species of this class are often content with making a *single* cake; *some* give it no more than two or three inches diameter, *others* give it five or six inches. Sometimes however they make two or three cakes parallel one to another.

There are in the kingdom wasps of *this* class that give their nests very singular covers. Mr. Varignon brought one of them to the academy some years ago, whose covering resembled very much a rose not yet *blown*; It

Vid. plate
5. fig. 2.

was

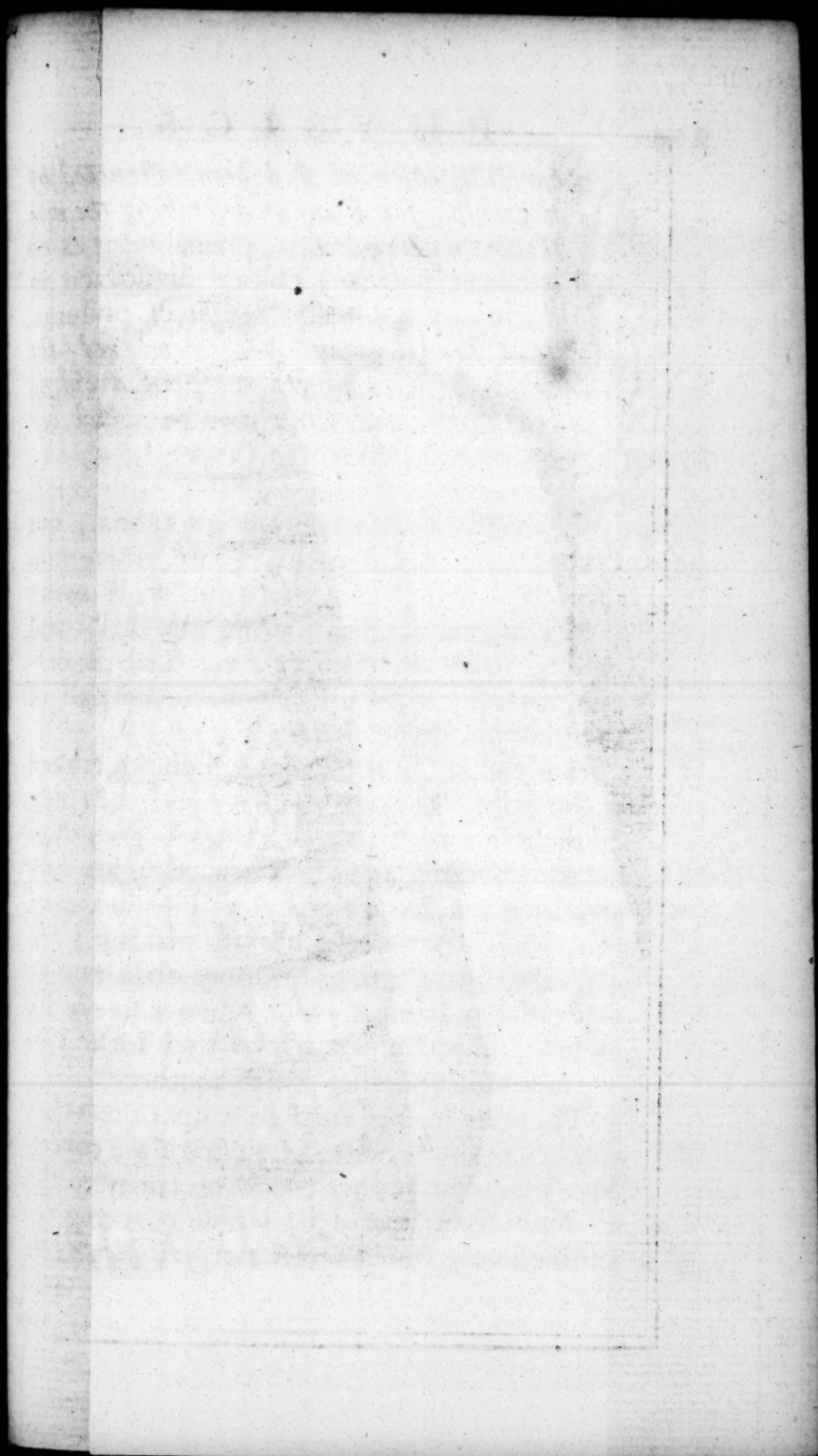


Fig. 1.

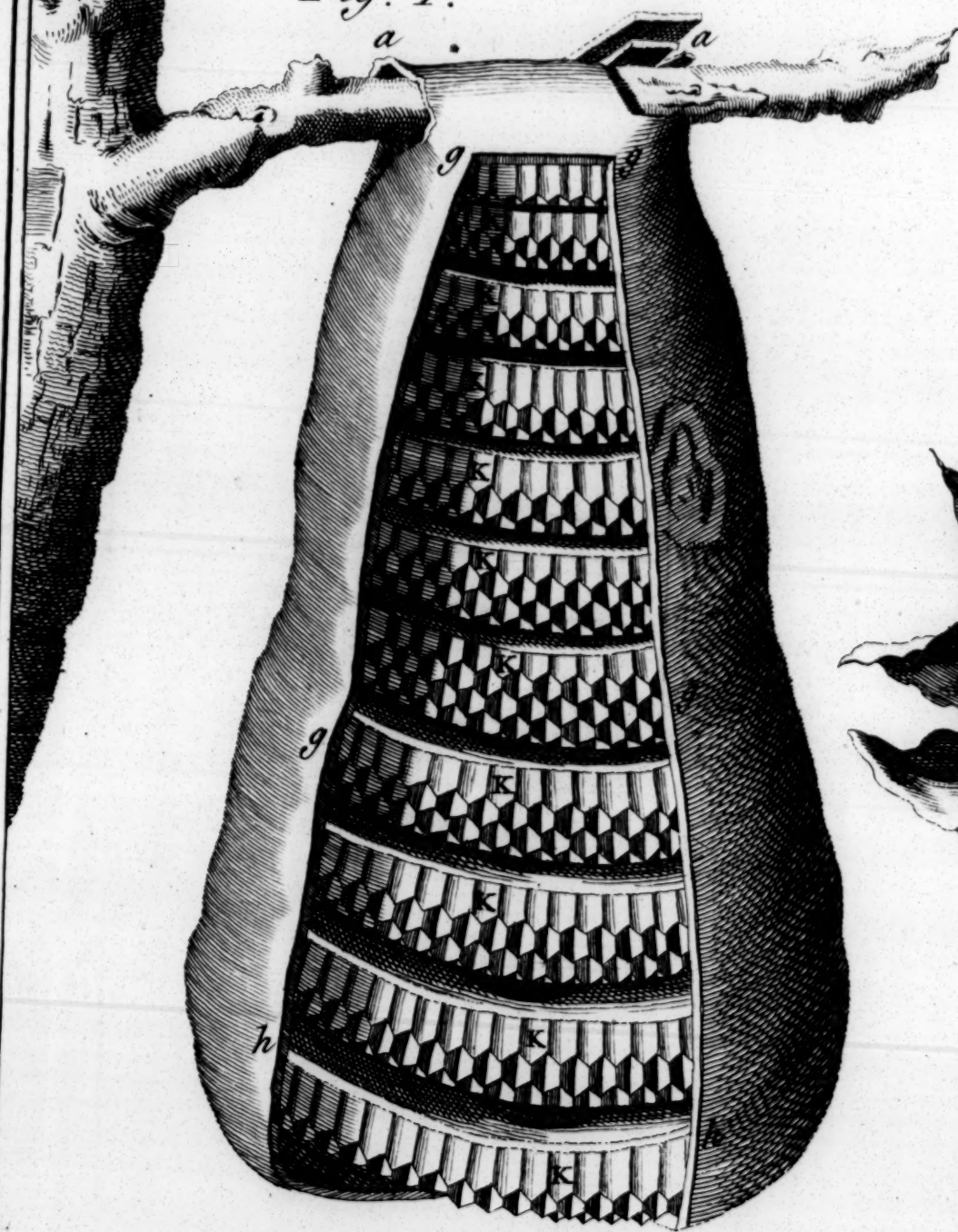
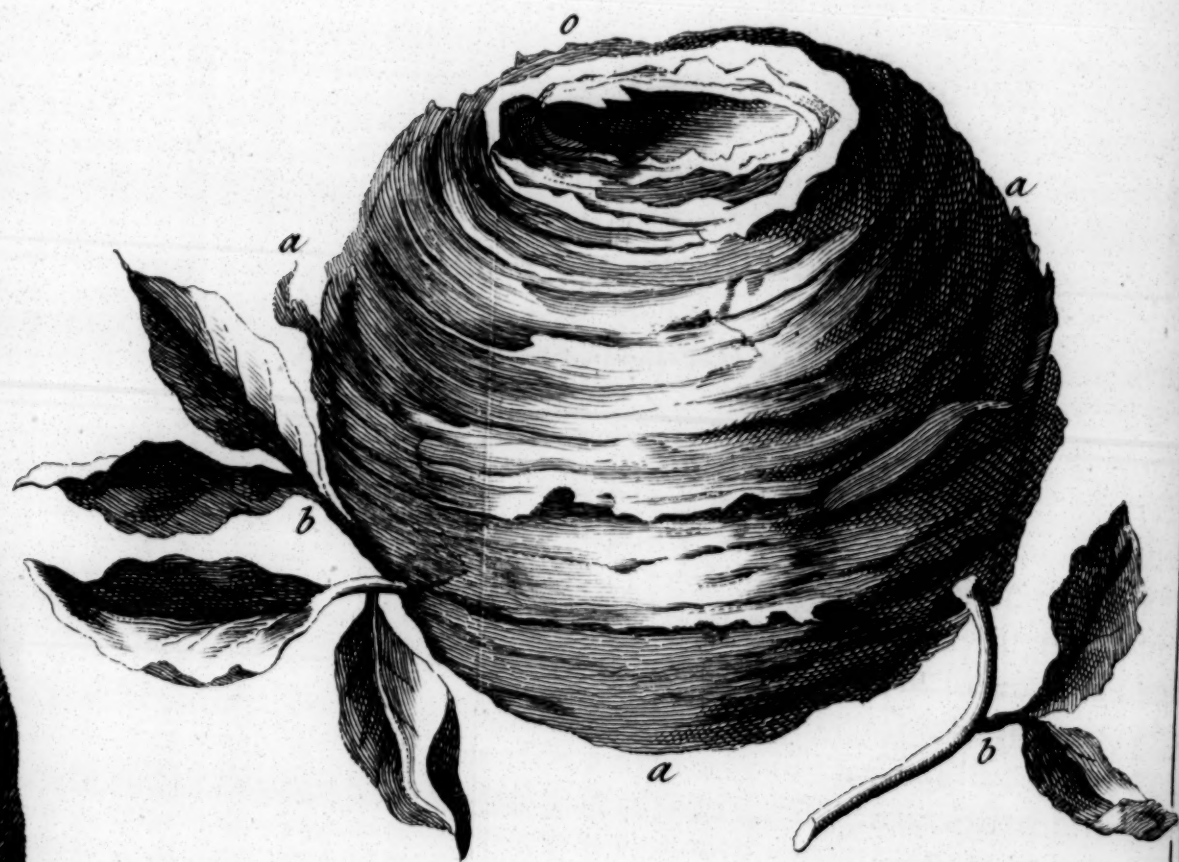
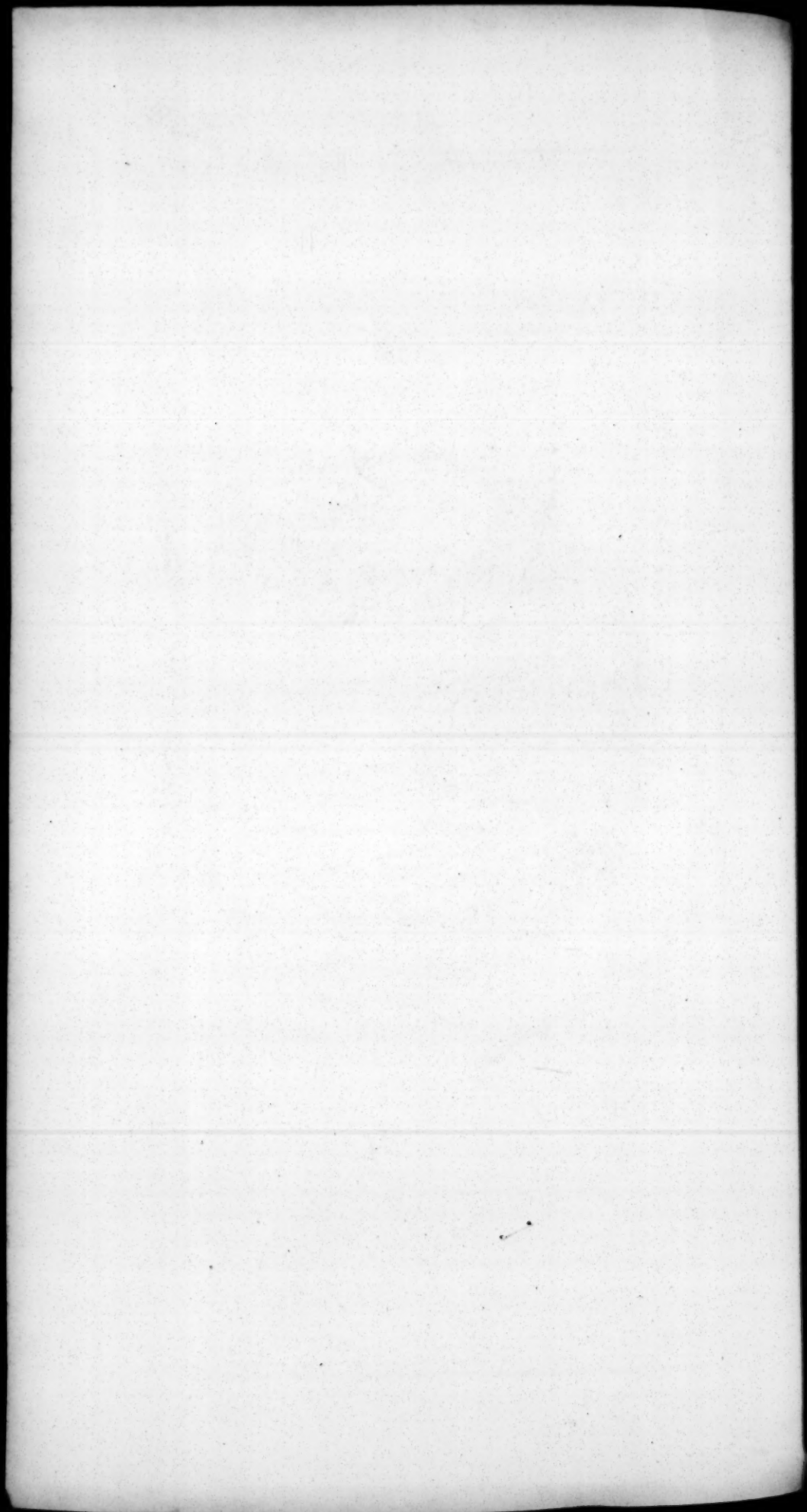


Fig. 2.





was in *like manner* composed of several leaves applied one upon another.

But all the wasps of this kingdom, that I know of, form nothing so singular as a species of wasp at Canada; whose nest is in the cabinet of the king's garden, and hath been communicated to me by Mr. Vaillant. At the first view, and even after having examined *some time* the surface, one would take it for a work of human composition. Its cover resembles so much our paste-boards, that it is not enough to say it resembles them; you can find no difference between the one and the other: it hath the polish, the colour (which at present is *that* of old paste-board but was formerly white) and likewise the texture. It is a fine paste-board and as thick as *that* of common portefolios. This cover approaches in figure to a cone, but the summit of the cone is not very pointed; near the summit it hath a long hole through which passes a branch of a tree, that had been chosen by the insects for suspending their nest, one could not draw out this branch without tearing the paste-board.

Vid plate
5. fig. 1.

The wasps of the second class, the biggest of all and called hornets, make in granaries and in hollows of trees their nests pretty much like *those* of our subterraneous wasps, only their paper is of a coarser sort, the predominant colour of it is yellowish, whereas *that* of the subterraneous wasps is an ash-grey.

The

The wasps of all these classes begin with building the first or superior cake. Before they begin on a cake, of whatever range it be, they form one of the columns that is to suspend it; upon the inferior *end* of this column they build the first cell of the cake; they surround it afterwards with other cells; they begin to form new columns in proportion as the increase of the number of cells requires it, and they extend the outward cover in proportion as the number of cakes enlarges.

The construction of the wasp-nest is not the only employment of the wasps, it is but a small part of them which are concerned in the building; the others have other employs. In order to shew their different occupations it is necessary to give a more perfect knowledge of the inhabitants of our little commonwealth, than we have hitherto given. What we are going to relate of them will serve to confirm the notions of Mr. Maraldi with regard to bees.

In the insect kind *those* which have stings are a people quite *distinct*, that have scarce any similitude with any others. The same wasp-nest is inhabited by three sorts of wasps different in size, and which have some differences likewise in shape; or they may be distinguished into three sexes, *males*, *females*, and such as I shall call *mules*, altho' they have nothing in common with real mules but their

inability of perpetuating their species: of which I am fully convinced by my own observations. The males are amongst wasps what the *drones* are amongst bees; the females in the wasp *state* hold the place of the king or queen amongst the bees. But instead of there being only three or four females, as in the bee-hive, I have seen in wasp-nests more than between two and three hundred at a time. Lastly, those of our wasps, which I call mules, are amongst *them*, what the *generality* of bees are in the bee-hive.

These mules are the most numerous part of this republic; they bear all the burdens of it; it is they that build, that provide food for the males, females, and even the young wasps for a great part of the year. Excepting those which are employed in collecting materials for the construction of the edifice, and in performing the office of masons, the rest go in pursuit of plunder; some catch insects, the paunch, and sometimes the whole insect is brought home to the nest; others pillage butchers shops; others ravage fruits and carry home the juices they have collected. When they are arrived at the nest they communicate their prey to the females, to the males, and even to other mules, who on account of their having been employed within doors could not go and provide *themselves* food. Several wasps assemble round the mule that is just arrived, and each takes his *portion* of what

what is brought. This is transacted with the utmost harmony ; the following observation is a proof of it. Those, which instead of going upon the chace have light upon fruits, bring back nothing *solid* to the nest, for they never carry fruits or portions of fruits. Yet these mules, which in appearance bring back nothing, contribute to the regaling their companions. I have seen them several times, after they have entered the hive, repose themselves quietly on the upper part of the nest ; after *which* they discharged from their mouth a drop of clear liquor, that was greedily sucked up, sometimes by two wasps at the same instant ; after that drop, the mule discharged a second and sometimes a third, which were distributed in like manner to other wasps.

The mules, altho' the most laborious, are the *least* in size ; they are the most lively, light, and active. The females are the *biggest* and *heaviest*, they move more slow and sedate. The bigness of the males is of a middle size between *that* of the mules and females.

During the months of June, July, August, and the beginning of September, the mother wasps keep themselves confined to the nest, they seldom go abroad but in the beginning of the spring, and in the month of September ; at the other times they are employed in laying eggs and feeding their young, which

is no small occupation; indeed *by themselves alone* they could never sufficiently attend such a prodigious number of young as we have *before* calculated each wasp-nest contains. They feed them as birds feed their young ones. Every moment they are carrying them a bill full. It is surprising to see the activity with which a mother wasp runs through the cells of a cake one after another; she puts her head pretty far into those cells where the young are very little, what passes *there* is concealed from the eye of the observer; but it is easy to *conjecture* by what one sees done in those cells where the young are bigger and ready to undergo their metamorphosis. Those we have last mentioned being more advanced are less quiet, they put forth their head quite out of the cell, and by little gapings seem to crave for food. The wasps of the larger sort, the hornets, before they give food to their young, press a little their head between the two talons we have so often mentioned. I am inclined to think that the attention of the wasps goes so far as to adapt the food to the strength of the young, for I have seen *some* give but a drop of *liquor* to such as were pretty big, and have seen *solid* food given to such as were bigger. The mothers not being sufficient to distribute nourishment to so many young, the mules are often employed in that service. I have made an observation on the wasps of the first class, which seems to prove

that *they* feed their young in the manner of birds which *disgorge*, that is to say, swallow the grain and let it soften a little and be concocted in their crop, before they offer it to their young ; for I have seen a mother wasp of this sort, which brought home the paunch of an insect, after having swallowed it intirely, go through her cells and leave the young some pieces *so large* that they were scarce able to swallow them.

I have taken away fragments of cakes, full of little wasps, which for want of the mother's bill sucked what I gave them. It would not perhaps have been impossible to have *reared* them, if one would have taken the trouble.

N. B. *This experiment hath been since tried with success by a youth, who took pleasure in feeding wasps with honey, as the generality of boys delight in breeding birds.*

Vid. Mr. De Reaumur's history of insects vol. 6. pag. 190.

The young wasps are not in the cells under the *form* of wasps ; when they have taken *that* they remain there but a little time. They are produced from a white, transparent egg, of an oblong figure, very like the kernel of a pine apple, excepting that it is bigger at one *end* than at the other. Eight days after the egg hath been laid you find in the
cell

cell a worm, which is considerably bigger than the egg; perhaps this worm is the egg itself more developed; the head is *then* discernible, you may distinguish the two talons. The worms continue to grow till they become big enough to fill intirely their cells. When they are arrived at that size, they are ready to undergo their metamorphosis; they have no longer need of taking food, they enjoin themselves a fast, and forbid all commerce with other wasps. They stop up the mouth or entrance of their cell, by making it a little cover; some worms make it almost *flat*, *these* are commonly such as are to be mules, others make it *convex*, and even extend *a little* the sides of the cell by making a border of the same materials as the cover. The cover is of a texture like *that* of the cod of caterpillers or silk-worms. Our *worms* of wasps spin and weave this cover precisely as caterpillers spin their cod; they give themselves the same motions of the head. The thread, of which they form it, is so fine that I could never observe exactly from whence they draw it, altho' I have sometimes held in my hand the cakes where the worms were at work in inclosing themselves. It appeared, however, to me that the thread came like *that* of caterpillers from a little below the mouth. In about 3 or 4 hours the cover of a cell is intirely finished; I have often taken pleasure in breaking *those* that were begun,

in order to make them renew their work; but it is necessary that there be remaining still a *provision* of filk in the worm; for if you destroy a cover that hath been made several days, the worm will weave no more. These covers are extremely white, particularly in the nests of hornets.

I have not made very exact observations on the number of days between *the laying* the egg and the worms *inclosing* itself in the cell. I think however that the number of days in the wasps of the first class doth not exceed one and twenty. This I am certain of, that the worms of the wasps of that class do not continue above nine days in their cells, after they have stopped them up. A little after the worm hath inclosed himself, he is transformed into an *aurelia*; he quits his ancient *case* or skin, and is cloathed with *one* extremely thin, and so transparent that it lets the shape and colour of all the parts of the wasp be seen, altho' the insect is as it were swaddled in it. At last, about the 8th or 9th day the insect strips off this last covering, and appears under the form of a fly. The first *case* or skin remains so exactly applied to the sides of the cell that it seems to make a part of it. The wasp, that hath just disengaged himself, begins with making use of his talons or teeth, as we have described them before; which he employs in nibbling *all round* the cover that inclosed him; the cover being
thus

thus detached, he quits his *abode* with ease. The hornets or large wasps begin with nibbling their cover in *the middle*, and enlarge the hole continually till it can let them pass through.

The wasp that is just at liberty from its cell is not different from those of its species and sex but in this, that it is of a more pale yellow or citron colour; he soon takes the benefit of the food, that hath been brought to the nest by others. In wasp-nests, that are without an external cover, I have seen wasps which the very same day that they were transformed went into the country, and brought back plunder, which they distributed to young wasps in cells. The cell from whence the young wasp is departed doth not continue *long* vacant; as soon as it hath been quitted an old wasp is employed in cleansing it: in a few days you find *there* a new egg; thus the same cell serves for breeding several wasps.

As the mules are six times smaller than the females, their cells are pretty near in the same proportion. When we said therefore that in a square, whose sides are of an inch and half, there are 49 cells, we meant only the cells of mules: the same square contains much fewer cells of female worms; *these* last mentioned are likewise *deeper*, because the females exceed the mules in length as well as bigness.

There are not only cells built solely for breeding *mule worms*, and others for raising up *females* or *males*; but it is to be remarked that the cells of mules are never intermixed with *those* of males or females. A cake is intirely composed of cells for mules, but the cells of females and males are mixed in the same cake; they have need of cells equally deep. The males indeed do not want such wide cells as the females, and therefore *theirs* are much narrower, in the proportion that the difference of size requires.

These piles of cakes, the massy columns that support them, in a word, the whole edifice we have been describing is a work destined for a few months only. Those habitations so peopled in the summer are almost desarts during winter, and intirely abandoned in the spring; not a single wasp remains within them. *Those* that have out-lived the severe season go and begin a new edifice, which together with its future inhabitants owes its origin to a *small* number of wasps, and sometimes even to a *single* wasp.

One of the most singular remarks, that the history of these insects supplies, is that the cakes first formed are composed of cells that can contain none but mules. The republic, whose foundations are just laid, hath need of *labourers*, and *those* are born the *first*. No sooner is a cell finished, and oftentimes it is not above half built, but an egg of a mule worm

worm is deposited in it. As they are first born, so likewise they die the first; whatever pains I have taken to cover well my hives, I never could succeed in having a single one alive at the end of a mild winter.

The females being much stronger and destined to perpetuate the species, support the winter better; but even of *these* there scarce remained a dozen living, some hundreds were perished in the hive.

I am not certain that the male wasps perish *all* in the winter as well as the males, yet I never could preserve any of *them* alive in my hives; but I think I have seen *some* flying about in the beginning of the spring.

A female wasp becomes the foundress of a republic, of which she is in the strict sense of the expression *the nursing mother*. The establishments they form are very far from being so useful to us as *those* of bees; they are indeed only noisome to us: yet we cannot help acknowledging that they have something in them more great and glorious: If the delight of glory be felt by insects, if solid glory amongst *them* be measured as amongst *us* by surmounting difficulties, by accomplishing enterprises useful to their kind, each mother wasp is an heroine to whom the mother bee, so respected by her subjects, is not to be compared. *In short, we may justly apply to her these lines in Virgil celebrating Rome;*

Felix prole virûm: Qualis Berecynthia
mater,

Læta deûm partu, centum complexa nepotes.

When the female *bee* issues from the hive where she was born, to become a sovereign elsewhere, she is attended by a swarm of workmen that are very industrious, very laborious, and ready to execute all the works necessary to the new establishment; whereas the mother *wasp* that hath not a single workman at her disposal, since we have observed that the winter causes all the mules to perish, the mother wasp, I say, undertakes *alone* to lay the foundations of her new republic.

The males, which I have already said that I imagine do not *all* perish like the mules, altho' not so idle as the drones or males of bees, yet seem not *by nature* fitted for relieving the female wasp in her most important labour, *that* of building. They are a kind of cotqueans never employed but in a sort of housewifry, such as keeping the nest clean, sweeping away the dirt, and carrying out dead bodies.

When the mother wasp begins in the spring to build under ground a nest, which hereafter will be peopled by so many thousand flies her future issue, she hath no longer need of consorting with the males; she was impregnated in the months of September or
October,

October, and at that time the numbers of males and females are pretty near equal, some hundreds of the one and the other in the same nest.

The courtship and the nuptial rites between the sexes are mysteries that have been revealed to me by means of my glass hives. About the middle of October I saw the females and the males come upon the outside covering of the nest, and keep *there* whilst it was heated by the rays of the sun. I could perceive their coupling performed pretty much in the same manner as *that* of other flies. I sometimes saw a male wasp in love, moving, as I may say, with a discontented air, now going forwards, then suddenly turning back; as soon as he saw a female, he ran, he fled with all the wings of love — *The rest I must throw a veil over, and refer the curious reader to Mr. De Reaumur himself in his history of insects*, vol. 6. pag. 200.

It is surprising indeed that a single insect should contain so many thousand embryos, but it is not the only instance that nature gives us of it; this fruitfulness is perhaps much inferior to *that* of many sorts of fish.

The females and the males have a *sting*, the males *alone* are unprovided with it. The sting of the females resembles *that* of the males, but is much longer and bigger. The violent smart it occasions is produced by a venomous

nômous liquor, that is very limpid, introduced into the wound.

Peace doth not always reign in the republics of wasps; there are often combats between mule and mule, and between mule and male. The *last*, altho' bigger, are more weak or greater cowards; after having held out a little while, they betake themselves to flight: in general the combats seldom end in death, tho' I have sometimes seen the male killed by the mule. Our female wasps are less murderers than the bees; they do not treat so ill their males as the bees treat their drones.

But now the scene changes; about the beginning of October the wasps cease to think of nourishing their young; from *being* tender mothers and nurses they become unmerciful step-mothers; they tear out of the cells the worms that have not yet inclosed themselves, they carry them out of the nest; mules and males are employed in the cruel work, but I never saw a female engaged in these barbarous expeditions. It is not one single species of worms that the wasps attack, (as Mr. Maraldi hath observed of bees, who at a certain season destroy the worms of drones) mules drag their fellow mules, and males tear to pieces males; the massacre is general. Shall we endeavour to conjecture the reason of such apparent barbarity? Is it that they chuse rather to put to death their young that they

they imagine they shall not be able to rear, or that they judge will never come to any thing on account of the cold weather they are threatened with? for the cold pinches them all extremely. As soon as the hoar-frosts begin they never stir abroad, till the sun hath warmed the air; as the cold increases, they have not strength to pursue the flies, that are their prey; at length the cold destroys them. A few females only survive; *these* pass the winter without eating, for they do not make *stores* like the bees, indeed if they had *any* they would not make use of them: I have often put into their nest sugar, honey, and other foods which they were fond of in the summer, but in the winter they did not touch them.

In every season on days of continued rains and high winds they never stir abroad; all keep fast, for they have nothing *provided*.

The subterraneous places inhabited by our wasps prove that they are naturally great miners, that they make holes and turn up earth with great dexterity. Perhaps they may take advantage of holes that have been made by *moles*, but *still* there must be a great deal of earth to remove in order to make those holes 14 or 15 inches diameter, which the size of their nest very often requires. If you stop up the mouth of one of these holes with earth, as I have often done, they do not long continue prisoners; in a few hours they get thro' this

this new earth, and remove it away ; for the performance of this work they make use of their two talons or teeth.

The sting of the wasp is an hollow tube, open near its point, at which opening issues the venomous liquor. Having been stung by a wasp I bore it with patience, and let her draw back her sting at leisure ; I then caught her and put her on the hand of a servant, whom I had disciplined *so* as not to regard *being stung* : after having provoked the wasp she stung him, but the smart was very little ; I immediately took the wasp and made her sting me a second time ; I scarce felt it, the venomous liquor had been almost exhausted ; I then provoked the wasp, but in vain, for she would not inflict another wound.

This experiment and some others, that perhaps no one will have an inclination to repeat, have discovered to me that if you let yourself be stung peaceably, the *sting* never stays behind in the wound ; it is flexible, doth not pierce an hole direct, but makes the wound in zic-zac : if you oblige the wasp to draw it back suddenly, the friction is great enough to retain the *sting*, which is as it were a little hooked in, so that she tears it away ; whereas if you do not hurry the wasp, she gently disengages it by little and little.

Memoirs 1719, pag. 230.

But

But as Mr. De Reaumur hath made some corrections of his memoir, presented to the academy, in his edition of the history of insects, vol. 6th, I have in some particulars extracted from thence.

This kind of insect so destructive to our woollen manufactures and to our furs, is but too well known by the ravages they commit; yet the mischief they do us hath not hindered the most eminent writers in natural history from speaking of them with encomiums. Their industry strikes us with admiration as soon as we apply ourselves to the study of them.

Of moths
by Mr. de
Reaumur.

Enquiries of natural history, had they only for their object to display the prodigious variety of *beings* in the universe, though they should only assist us to form more enlarged ideas of the author of so many marvellous works, deserve not to be treated as frivolous; for *so* they sometimes are, by people who do not in reality propose to themselves more solid objects: but in fact such enquiries, as are merely curious in appearance, may tend as directly, as *those* of any other kind, to what we call real utility, to what hath relation to our wants and conveniencies. A thousand examples concur to establish this truth, that observations in natural history have contributed as much to the progress of arts, as the most beautiful inventions in mechanics.

Whoever

Whoever by studying the nature of moths, by observing them carefully throughout their whole existence and under all their forms, should arrive at the discovery of some secret for destroying them, or for defending from their teeth such of our manufactures as are their usual prey, would not *he* have discovered something as useful, as *one* that should find out a new method of manufacturing wool, which would considerably increase the duration of the stuffs made from it? This consideration alone was more than sufficient to determine me to follow with attention a species of insects, that in other respects invites observers by abundance of singularities, and yet hath never been hitherto considered with accuracy.

Hairs, feathers, scales, and shells, cover the external surface of the body of different sorts of brute animals; nature hath given *them* very solid coverings, to defend them from the injuries of the air, and from the frictions of bodies which would otherwise gall them; *we* supply by art and industry what hath been refused us by nature. She hath likewise refused vesture to the moths, but hath taught them to clothe themselves with stuffs very like to *those* which we employ to the same uses. Their head, their talons, and six paws, which are situated near the head, are all that they have *scaly*; the rest of their body is covered with a white, thin,

thin, and transparent skin, and consequently must be extremely tender and delicate: you barely see a few hairs dispersed up and down through their whole body. They may truly be said to come into the world *naked*, and to make themselves real cloaths; some make them of wool, and others of hairs; I say *real cloaths*, because the coverings of moths ought not to be confounded with the cods that silkworms and divers caterpillers form; these *last* are *closed* on all sides, the animal includes himself *there* in order to undergo his metamorphosis; he is to continue *there* a considerable time without moving or taking nourishment; whereas the moths never quit their kind of habit, but wear it wherever they go. It is this contrivance of the moths to clothe themselves that naturalists have admired, and indeed have been content with *admiring*, for they have not taught us by what artifice the insect manufactures, if I may be allowed that expression, the stuff with which he covers himself, nor what is its texture.

The moth is not of a shape very difficult to be adjusted; the body of the insect is of a form approaching to a cylinder; in order to cover it there is wanting only a sort of tube, and *such* is its cover: it is an hollow tube that runs the whole length of the animal, open at the two ends; near which it hath commonly a little less diameter than towards the middle; in the oldest moths it is
between

between four and five lines in length, and very rarely six. All the external part of this tube, or, as we shall most commonly call it, *sheath*, is a sort of woolly texture, sometimes green, sometimes red, and sometimes grey, according to the colour of the stuff from whence the moth had pilfered. Sometimes divers colours are found mixed in very singular varieties; most commonly these different colours are disposed in the manner of *stripes*. It must be observed, that it is only the *external* part of the sheath which is of wool; all the *inside* is a white-grey filk, spun by herself. You may consider it as a *lining* to the rest of the stuff, or rather the sheath is made of a sort of stuff, in which the greatest part of its thickness is of wool, and the rest is of filk; a kind of tissue that we have not yet thought of imitating.

The state of the moth, like that of the caterpillar, is transitory; they are in the same manner to be metamorphosed into butterflies, and it is under this last *form* that the females deposit eggs to perpetuate their species. From the middle of spring to the middle of autumn you see, flying upon hangings and beds, little butterflies of a greyish-white, against whom the good housewives proclaim just war. These are the butterflies into which the moths have been transformed. In order to trace our insects from their birth, I have taken several butterflies of this kind,

I shut up some that were very lively in cylindrical glass bottles, (called in French *poudriers*) the mouth of which is pretty near as wide as the bottom: into these glass bottles I had put some pieces of *stuff*, some of these butterflies laid their eggs *there*. The eggs are very small, it is as much as good eyes, without the assistance of a glass, can do to see them; you may discern their figure to be like *that* of common eggs, they are white, and have a sort of transparency. I was not able to remark the worms at the time they were hatched, nor to know precisely how many are hatched; all that I know is that about three weeks or a month after the butterflies had deposited their eggs, I found little moths, and no longer found the eggs whose *places* I had remarked.

In a very little time after they are born they begin to make their cloathing. You find them wrapt about with their covering, when they are yet so small that you cannot be assured of their being *covered*, without the assistance of a glass. What nature teaches is learn'd early.

But to pursue the artifice of their labour, we must take them in a more advanced age. For example; let us confine ourselves to a moth of a sensible bigness, such as *one* of two or three lines. As her body grows, the sheath will soon be too short to cover her, so that the insect is every day employed in

lengthening her garment, which entirely covers her when she is not in action. We have already said that it is open at both ends: when the animal would work in making her garment *longer*, she puts forth her head at that end to which it is nearest; you see her extremely active in searching after proper nap of wool; her head changes from place to place continually. If the nap that is near is not such as she would have, she draws sometimes more than half her body out of the sheath, in order to seek for better at a greater distance: when she hath found such as suits her, her head is fixed for a moment, she seizes it with two talons, that she hath underneath her head and near her mouth, and tears it up after repeated efforts; immediately she conveys it to the edge of her tube or sheath, to which she fastens it. She repeats the like work several times successively.

I said that the moth *tears up* this bit of wool from the stuff, and in reality you see her pull as if her design was to tear it; but I know not whether she doth not cut it, the shape and situation of her two talons, together with the use she makes of them in other circumstances, concur to give me this notion.

If the moth repeated continually the work we have been mentioning at the *same* end of the sheath, she would only lengthen it at *that* end, she would not give it the shape of a spindle, as it commonly hath. It is therefore

fore necessary for her to lengthen it successively at each end; and in fact she doth *so*. After having worked for a minute, and sometimes only a few seconds, at one of the ends, she thinks of making it longer at the other; one is surpris'd to see the head come out at the *latter*, which before came out at the *former*; one is almost inclin'd to think that the insect hath two heads, or at least that the end of the tail is made like the head, and hath the same cunning in chusing and gathering the bits of wool. The truth is however that it is the head which appears successively at the two ends of the sheath. In order to explain *this*, it must be observed that the sheath is much wider than is necessary to contain the body of the insect, it hath almost double the diameter of the animal. When the head hath worked sufficiently at one of the ends, she bends herself round, and advances her head towards the place where her tail was; she continues advancing it till she is bent almost double; *then* she draws back her tail towards the place that was before occupied by the head: thus the insect turns herself in her sheath from the one end to the other. She performs this *turning* so quickly, that one would not think she could have time to do it.

I was willing to see her perform this motion in such manner as to leave no room for doubt. By pressing gently one of the ends

of the sheath, I obliged the moth to advance a little towards the other end ; I *then* cut off with my scissers the part which I had forced her to abandon ; the same contrivance repeated successively at each end, reduced the sheath to a third of its former length. The insect being by this means more than half *bare*, and under a necessity of cloathing herself anew, laboured at it very hard : I *then* could see in what manner she bends herself double in turning her head from end to end. Under this circumstance the main part of the fold of her body was out of the sheath, but commonly it is in the middle of it ; and it is on this account that the middle is more swelled out than the rest. In this case likewise it was very easy to observe her work ; she performed more in 24 hours, than she would otherwise have done in several months, necessity urging her to a new cloathing.

When the moth, in labouring to lengthen her sheath, doth not find a nap of cloth to her *liking* as far as her head can reach, she changes place from time to time ; she moves with a good deal of speed, always carrying her sheath with her ; *then* her head and her six paws are out of the sheath, for it is by means of those feet that she moves. She hath two other paws, that are shorter, situated near her tail ; the use of these is to fasten herself to the sheath ; they take hold of it, and make it advance with the body of the animal,

animal, whilst the other feet advance her forwards; she stops *where* she finds a suitable nap, and works at extending her sheath.

We have yet only described the half of her work: at the same time that the insect becomes longer, she grows likewise bigger: very soon her garment would be too strait about her, and not let her perform all her necessary works. I discovered by very accurate observations, that the moth doth not cast off her habit when it becomes too narrow, like the crawfish, but actually enlarges it; and tho' the manner of her enlarging it is very simple, I did not at first conceive it.

I put some moths, whose coverings were of a single colour, upon stuffs of a single but different colour; moths with blue sheaths upon red cloth, *those* with red sheaths upon green or grey, &c. After some time I saw the tubes made longer and wider; as circular folds, made of the nap of the new stuff I had given them to nibble, shewed the lengthening of each end, so two stripes that went in a straight line from one end to the other, shewed the widening that had been made. These two stripes were parallel one to another, and each pretty near equally distant from the upper and under part of the sheath. I take for the under part *that* which covers the belly, and for the upper what covers the back.

It remained to know in what manner the moth undertook to make these enlargements along the whole length of each side of her sheath. By diligent observance at different times, I perceived the manner she sets about it to be precisely the same as we should undertake in the like case: we should not know what else to do, in order to enlarge a garment too narrow, than to cut it through its whole length, and to put *in* a piece of a suitable bigness between the parts separated; we should put *in* a like piece on each side, if the shape, such as the moth's is, in the figure of a tube, required it. Now *this* is the very thing done by our insects, with this precaution moreover, which is necessary to them, in order to prevent their being naked whilst they are at work in enlarging their garment; that [instead of two pieces, which should have each the whole length of the sheath, they put in four, which have each only half the length. By this means they cut through no more than the half of their *sheath* at a time, *the rest* is sufficiently supported, and gives them a shelter till they are able to close the part that is separated. I have seen *some* that began to make the *slit* in the middle,* and carried it *on* to one of the ends of the sheath. The same talons, that they make use of for pulling up the nap of the cloth, are the tools which they employ in flitting their sheath. They cut it some-
times

times so exactly in a straight line, the two edges of the slit are so little fringed, that *we* could not do it better with scissars or a razor : the slit hath not the least appearance of being made by *tearing*, no thread juts out beyond the others.

I have seen *others* that did not begin their slits necessary for the enlargement in *the middle*, but began *them* at the end or near the end, and carried them *on* to the middle. With regard to the time employed in each of these methods there is the utmost variety ; neither every moth works alike, nor is the *same* moth in an equal humour for working. *Some* after having made an hole in the middle of the sheath, have spent two hours in carrying *on* the slit to the end ; others have done it more speedily, and others more slowly ; but none have been longer than from one day to another in putting *in* the piece that is to fill up the slit.

Their industry in lengthening and in enlarging their sheath hath been sufficiently explained, but we have not perhaps clearly enough shewn what is the texture of the stuff of which it is made. At the first sight one perceives that shagged wool is the principal material, but we have already said that more attentive observation discovers that silk likewise enters into its composition, that its *external stratum* is of wool and silk, that its *internal* is of pure silk. How is *this* lining

of filk applied? By what artifice are the little bits of wool united together? The whole mechanism is unravelled as soon as it is known that our insects *spin*, and that they are in a condition to spin as soon as they are born. The thread that is spun issues from a little beneath the head, like *that* of caterpillars. It is so *fine* that it is with difficulty perceived, unless by a good microscope; it is strong enough however to keep the insect suspended in many circumstances, and by this *effect* alone is it known at first that there is such a thread. With this filken thread the insect ties together the different bits of wool which compose the sheath, insomuch that the texture may be compared to a stuff, whose warp should be of wool, and woof of filk. It is not easy to see whether it is interwove so regularly as we should do in the like case; but it is certain that *we* should scarce be able to make it so close and compact. Perhaps it is not so necessary to be interwove; insects that spin have an advantage which *we* have not; the threads that are but just come out of their body are still glutinous; it is sufficient only to apply and press them against other threads, in order to attach them firmly together. It is probable however that the moth does interweave her threads with the threads of the wool, and is not content with gluing them one to another; one sees the hole that is underneath her mouth furnish,

nish, as the shuttle would do, a thread proper for interweaving; and one sees her head perform quick and lively motions in opposite directions. The same thread that forms the woof of the superior texture, being interwoven *singly*, in the manner that caterpillars work the threads with which they compose their cods, forms the texture which serves for a lining.

In their common labour one cannot discover whether the insect begins by making that part of the texture, which consists of wool and silk, or by *that* of pure silk. But you may force them to reveal their whole procedure by constraining them to cloath themselves anew. In order to force them to *that*, I have introduced into one of the ends of the sheath a little stick pretty near equal in diameter to the body of the insect, and pushing the stick have obliged the animal to give way, so that by little and little I drove her out of her *case*. The moth being *thus* made naked was under a necessity of covering herself anew. She had the courage to undertake it, notwithstanding what Pliny says, who affirms that they die if taken out of their sheath; which may be true, if all the precautions I took be not carefully observed. In divers experiments of the like kind that I have made, the moth hath always chose rather to make herself a new habit, than to return back into *that* she hath quitted, which cost her

her so many months labour. In vain have I placed their sheaths near them, I never saw *any* make an attempt to enter them. *Some*, after having been stript, continued half a day restless, wandering, and at length determined themselves. They began with spinning a *covering*, which was somewhat whiter than the cobweb of house-spiders, but pretty near of a like consistence; this cover was commonly finished in one night: in five or six days at most the filken sheath was entirely covered over with wool. Thus in a few days she performed the work that she is not accustomed to finish under several months. The moths forced to cloath themselves quite anew, set about it precisely in the same manner as when they were but just born. I have observed such as had been hatched only a day, begin with making themselves a sheath of pure silk. I have seen them afterwards attach to the middle, and all round this sheath, a ring of woollen threads laid parallel one to another, and inclined a little along the length of the sheath. The reader will easily imagine that the assistance of a good glass is necessary for the observance of these particulars. Our little insects afterwards lengthened that ring by a new range of woollen threads, and so continued joining to each rim of the preceding ring a new successive range of threads, united by her *home-spun* silk.

The habit that a new-born moth, small as she is, makes for herself, is always excessively too big, as if she was willing to save herself the trouble of enlarging it soon. Indeed they hang quite loose in their garment. I have sometimes shaken a little piece of cloth covered with moths, that had newly dress'd themselves, upon another piece of cloth on which I had a mind to make them work, and I found none but naked moths fall off.

As these insects are transformed into butterflies, there are every year a great number of *cast-off* sheaths: the young moths appeared to me to prefer the wool, with which *those* had been made, to *that* of stuffs; *there* they find materials prepared, and the threads of wool already cut of a proper length. The new-born moths seem to affect chiefly a white wool, and pick out the threads, that may be discerned by a microscope even in coloured cloths to be undied; as they become older, they grow fond of party-coloured drefs.

On certain days, particularly in the winter season, our insects lie idle; they have likewise their holy-day times, but shorter, in the summer and autumn; *then* they fix their sheaths upon a stuff they have nibbled before. If the sheath was merely *laid* upon the stuff, it might be thrown on the ground by a thousand accidents; but the insect *fixes* it in such manner, that there is nothing to fear. He fastens at each end of the sheath several bundles

bundles of threads, which are all glued at the other extremity to the stuff; *these* are so many ropes, as I may say, for keeping the sheath at anchor.

The wool of our stuffs not only furnishes them with cloathing, but furnishes them likewise with food; they eat and digest it. If it be remarkable that their stomachs should digest and dissolve such substances, it is no less remarkable that they should occasion no alteration in the colours with which the wool hath been dyed. The excrements of these insects are little grains, which have precisely the colour of the wool on which they have fed. There are no *sands*, in the cabinets of the curious, that shew such diversities of colours, as the excrements of moths that have lived upon hangings which have varieties of colours.

At length, when they are come to their perfect growth, when the time of their metamorphosis approaches, they often abandon these woolly stuffs that had furnished them till *then* with food and raiment; they seek *places* that can afford them more firm defence than tissues which may be shaken by every breath of wind. *Some* go and establish themselves in the corners of walls, others clamber up to cielings: those that in the course of the year had ravaged the seat and back of elbow-chairs, nestle themselves *then* in the little chinks between the stuffing and the wood:
those

those that I have kept inclosed in bottles whose mouths were very open, have commonly been collected under the lid. Whatever *place* they have chosen, they fasten to it their sheath, most commonly at both ends, but sometimes only at one end; some fix it parallel to the horizon, others in angles variously inclined: it did not appear to me that they are particularly fond of any position. One thing they never fail to do, which is, to close well the openings of the two ends of their sheath with a silken web. The insect *thus* inclosed very soon changes her form, she takes *that* of a chrysalis, which is at first of a white ground lightly yellowish, and passing successively through deeper *tints*, becomes a reddish yellow. After having continued a chrysalis *some time*, the precise duration of which I do not know, but it doth not exceed three weeks, she pierces a hole in one of the ends of the sheath wherein she inclosed herself; she advances forth her body half way, still under the *form* of a chrysalis, but is to keep *it* no longer than a few hours, for she breaks through that yellow-coloured covering which gave her that *form*; and then you see her sally forth, and fly away a whitish-grey butterfly.

Amongst *these* butterflies, as well as amongst *those* of other sorts, there are males and females. The difference of bigness, that in many of the classes of butterflies distinguishes

bundles of threads, which are all glued at the other extremity to the stuff; *these* are so many ropes, as I may say, for keeping the sheath at anchor.

The wool of our stuffs not only furnishes them with cloathing, but furnishes them likewise with food; they eat and digest it. If it be remarkable that their stomachs should digest and dissolve such substances, it is no less remarkable that they should occasion no alteration in the colours with which the wool hath been dyed. The excrements of these insects are little grains, which have precisely the colour of the wool on which they have fed. There are no *sands*, in the cabinets of the curious, that shew such diversities of colours, as the excrements of moths that have lived upon hangings which have varieties of colours.

At length, when they are come to their perfect growth, when the time of their metamorphosis approaches, they often abandon these woolly stuffs that had furnished them till *then* with food and raiment; they seek *places* that can afford them more firm defence than tissues which may be shaken by every breath of wind. *Some* go and establish themselves in the corners of walls, others clamber up to cielings: those that in the course of the year had ravaged the seat and back of elbow-chairs, nestle themselves *then* in the little chinks between the stuffing and the wood:

those

those that I have kept inclosed in bottles whose mouths were very open, have commonly been collected under the lid. Whatever *place* they have chosen, they fasten to it their sheath, most commonly at both ends, but sometimes only at one end; some fix it parallel to the horizon, others in angles variously inclined: it did not appear to me that they are particularly fond of any position. One thing they never fail to do, which is, to close well the openings of the two ends of their sheath with a silken web. The insect *thus* inclosed very soon changes her form, she takes *that* of a chrysalis, which is at first of a white ground lightly yellowish, and passing successively through deeper *tints*, becomes a reddish yellow. After having continued a chrysalis *some time*, the precise duration of which I do not know, but it doth not exceed three weeks, she pierces a hole in one of the ends of the sheath wherein she inclosed herself; she advances forth her body half way, still under the *form* of a chrysalis, but is to keep *it* no longer than a few hours, for she breaks through that yellow-coloured covering which gave her that *form*; and then you see her sally forth, and fly away a whitish-grey butterfly.

Amongst *these* butterflies, as well as amongst *those* of other sorts, there are males and females. The difference of bigness, that in many of the classes of butterflies distinguishes

guishes the male from the female, is not perceivable in *these*. We find indeed butterflies *from* moths of very different bigness: but these different sizes are rather marks of a different species, than of a different sex.

Methods
of destroy-
ing moths.

Having seen with how much art the moths array themselves, I cannot help lamenting that they should be *thus* ingenious at our expence, and that we should be obliged to declare war against such industrious insects. I learnt their genius by seeking methods to destroy them, and shall now reveal to the reader the poisons and destructive arts that my enquiries have discovered.

It is the common custom in houses, where they are careful of their furniture, to take down the hangings and beds *once* in a year, to have them beat and brushed. This method alone would be an excellent preservative against these insects, if it was but made use of at a proper season, which is when the young moths are just hatched, and there remain no more old ones, *namely*, about the middle of August, or at the latest in the beginning of September. It would be of little service to beat and brush the furniture at any other seasons; the insects, in a little time after they are born, nestle themselves so far *in*, and fasten themselves so tight, that the brushing would sweep off but few.

Modern naturalists, who have neglected to *observe* these insects, have not neglected to
teach

teach us *secrets* for preserving our stuffs against them; the only misfortune is that they never gave themselves the trouble to make trial of their secrets. You find great store of them, and pretty much the *same* in Aldrovande, Jonston, Moufet, as *those* related long before by Cato, Varro, and Pliny. Moufet pretends to prove that the ancients had a certain preservative, by the dress of Servius Tullius, which was preserved till after the death of Sejanus, that is to say, for more than five hundred years. If amongst the secrets which have been left to us there are *some* good, there are many *others* fit only to make the rest suspected. Pliny, immediately after telling us that those, who have been stung by a scorpion, have nothing to fear *ever after* from wasps, bees, and hornets, adds that we shall be less surpris'd at this marvel, when we know that an habit put upon a coffin is *for ever* protected from the teeth of moths. Rhafis, after having said that cantharides suspended in a house keep *them* away, adds that habits wrapt up in a lion's skin are perfectly secure from *them*; the skin alone of so terrible an animal appeared to him sufficient to frighten away such little insects. What hath been related in these different authors of the effect of various odoriferous plants, will appear to deserve *better* our putting them to the trial. We find in their works that savin, myrrh, wormwood, orrice, citron peel, aniseed,

seed, and divers others, put amongst stuffs, keep off the moths. Cato describes a preparation of olive-lees, with which he would have the coffers rubbed, wherein clothes are to be kept, and by which he assures us they are afterwards secure.

I have been far from neglecting to try the secrets that have been transmitted to us; yet thought I might without any danger of reproaches neglect the trial of *habits* put on a coffin, or wrapt up in the skin of a lion.

A reflection on a well-known fact directed me to try a method of making our stuffs disagreeable to these insects. We never find any moths attach themselves to the fleeces that are on the *backs* of sheep; if *that* wool was to their taste, it is probable they would lodge *there*, as another insect *does* which Rhedi hath described. Butterflies would go and deposit their eggs upon the fleeces, they would have nothing to fear from the pacific animals that bear them; it would not be requisite for them to have the boldness of a sort of fly, that even chuses the inside of the nostrils of sheep to lodge its *young* in; *there*, being moistened continually by a proper liquor, *they* grow till they are in a condition to be metamorphosed into flies: we have this account in the curious history of this insect, published by Mr. Valisnieri. Other flies go and wound animals covered with hair, they leave their eggs or *young* in the wounds they have

have made in their skin, where *they* grow like the worms of the galls or excrescences of trees, till they are ready to be metamorphosed.

The remark we have made extends itself to all the *skins of animals* that are covered with hair. *They* would in a great measure be always *bare*, if the moths established themselves *there* as willingly as they do, when we have manufactured *them*.

Let us carry this remark still further. *Fleeces* shorn from the sheep, which have not received any of those preparations that we give them in order to employ them for our uses, are not much more subject to be nibbled by the moths, than when *they* covered the sheep. The same thing is true with regard to furs; before *they* are dressed, the moths very seldom attack them.

By preparing wool and skins for our uses, we prepare them at the same time for moths; the first dressing we give them makes them a food agreeable to these insects. The wool that hath not received any preparation is called *greasy-wool*, it is *so* to such a degree that the fingers grow greasy by touching it. The first work upon it consists in clearing it of its *grease*; and as soon as it is scoured from *that*, the moths no longer spare it.

From hence it follows that in clearing wool from dirt and filth we ought to deprive it of its natural grease as little as possible: the

less hot the water is in which it is washed, the more you will leave of this grease; which can never do any mischief, when you employ the wool only in white stuffs, such as *blankets*, whose fate generally is to be cut to pieces by these insects.

But wool and stuffs that you would dye must absolutely be cleared of their grease: this put me upon trying whether a part of the *grease*, that had been taken from the wool, being restored to it again after it was dyed, would not make it disagreeable enough to the moths, altho' it should not be so much greased as to be perceptible by *us*. The manner of restoring back a part of the grease to the woollen stuffs is easy enough, it is but to take some hot water in which fleeces have been washed, and with a brush that hath been dipped in it, to skim over the stuffs you would preserve.

I beg leave to observe that it was pretty much in the same method that they got the beauty wash so celebrated amongst the Roman ladies,

Pyxidas invenies, et rerum mille colores;
Et fluere in tepidos cœsypa lapsa finus.

Ovid. Remed. Amoris, 353.

The success answered my expectations; and this effect of their *natural grease* invited me to try whether other *greases*, whether mutton suet, which had been prescribed as

a preservative against moths, whether butter, or oils of different sorts might be employed with success; but I found no grease or oily substance so disagreeable to moths, as the natural grease of fleeces. Indeed it was reasonable to presume that the *secret*, which nature employs to preserve the vesture she gives to animals, is at least *the best*. The *grease* of fleeces differs from *others* by a very strong rammish smell, which remains on the fingers that have but lightly touched wool. I have tried some oils, which far from keeping moths away seemed only to make them more *licorish*, such is the oil of nuts; they appeared on the contrary to *shun* the oil of olives; this last observation is favourable to the *recipe* prescribed by Cato, which is nothing but a preparation of the lees of olives.

Greasy substances were not the only things I tried, but all *that* others had taught and recommended, as well as *many* of my own contrivance; the result was that none of *them* proved absolutely fatal to these insects; that *some*, which had been delivered down to us as preservatives, were by no means disagreeable to them, but seemed rather extremely pleasing; I saw no moths grow better nor nibble faster than such as had been put on cloth, together with a great quantity of orrice root, which is one of the plants prescribed against them.

Moths placed on wool, offensive to their taste, have a resort to which they betake themselves. In case of necessity, their cloaths furnish them with food ; they yield to the most pressing want, and chuse to live better, and be worse cloathed.

It is happy for them that they have still another resort for repairing the ravages they have committed on their garments, and they repair them so well that the sight alone cannot discern any change, either in the texture or colour of the sheath, which they have nibbled. The sheath at first furnishes them with food, and their excrements afterwards furnish them with cloathing. Their excrements are little, round, dry grains, and precisely of the colour of the wool, that the insect hath digested. She fastens these little grains together by threads of silk, and disposes them in the *places* of the little bits of wool which she had plucked up ; thus the upper part of her garment preserves its form and colour.

Sheaths thus repaired almost *intirely* by excrements were the means of my discovering, that some of the substances I have mentioned before occasioned the moths to dislike certain stuffs.

In different places of the country I have seen women perswaded, that they preserved their clothes very well from moths by putting pine-cones in chests of drawers or in coffers, where

where they kept them. These traditions, which are commonly called *old womens notions*, are not always so despicable as is thought; there are *some* that have an excellent origin, and which well examined into would be found extremely useful; at least we have no right to reject *them* till our own trials of them have given us a right. Instead of pine cones I thought I might try something better in the same kind: *they* have a resinous smell; if *they* produce the effect that is attributed to them, it is probably owing to this smell. I thought it therefore better to try odours of *this kind*, but stronger and more penetrating than *that* of the cones. I rubbed one side of a piece of serge with a little turpentine; with oil of turpentine I lightly wetted one side of another piece of serge; and with each of these pieces I confined some moths.

The next day I found those which had been with the oil of turpentine all dead, and by a violent death, which had been preceded by furious convulsive motions; the greatest part were naked and stretched out stiff, having left their sheaths, which they never quit, and in which those that perish in the course of the year are constantly found.

The compassionate reader perhaps already pities the poor insects, that he foresees destined to perish in such torture, in order to confirm the preceding experiment, to pursue the circumstances of it, and to determine the

doses of the oil of turpentine, which gives so speedy or rather so slow a death.

To spare the reader the trouble, *and indeed the pain*, of reading the experiments that I made on this occasion, I shall only mention that it is not necessary to rub with the oil of turpentine the furniture which you would preserve from the moths; it is sufficient to shut it up in *places* where there is a strong smell of turpentine: you need only put pieces of paper or linnen, dipt in the oil, into chests of drawers or wardrobes, and leave them *there* for a day.

Being desirous of destroying moths by some odour that is less disagreeable to *ourselves* than the oil of turpentine, I tried the smoak of tobacco, which had the desired effect. By finding out methods of destroying moths, I discovered that the *same* would be instrumental in destroying other insects. Caterpillars of all sorts could no more resist the penetrating odours of oil of turpentine and the smoak of tobacco, than the moths; all perished that had the misfortune to be subservient to my experiments: flies, spiders, pismires, ear-wigs, fell victims to my enquiries.

I was eager to try the power of these smells against insects, of whom *we* may be said to be in *bodily* fear; it is not our furniture, but ourselves that bugs attack. The experiments I made proved that the smell of turpentine and the smoak of tobacco are capable of de-

livering

livering us from those stinking and blood-thirsty insects. These odours suffocate them very soon, altho' not so soon as the moths.

In order to describe the methods of diffusing these odours in the most efficacious manner, I shall begin with *that* of tobacco. Fill some chafing-dishes with charcoal not thoroughly kindled, upon which spread some handfuls of cut tobacco, such as smoakers use. The number of chafing-dishes must be proportioned to the extent of the room. The doors must be shut after you have placed the chafing-dishes with all proper precaution against fire. Little stoves might be made use of with less risk. If there be a chimney, you must hang a carpet or some thick coverlet before it, in order to prevent the smoak from issuing out. The windows likewise must be carefully fastened down; the goods and furniture must be unfolded and opened as much as possible for the smoak to penetrate. A thick smoak of tobacco confined thus for 24 hours will have destroyed the moths: after *that* you may expose the goods to the air, in order to take off the smell of tobacco.

I beg leave to observe likewise, that great care must be taken that no body continues or enters into the room during the operation; and even after the operation the doors should be thrown open, and left so a good while before any person ventures into the room; for the

Q 4

smoak

smoak of charcoal alone is very suffocating, and hath been often found instantaneously fatal.

Furniture in which there is silver employed, and which has delicate colours, would be tarnished by the smoak of tobacco; for *such* it will be better to have recourse to the oil of turpentine; the effect of which will be the greater, as the smell is stronger. The strength of its smell will be less proportioned to the *quantity* employed than to the *extension* of its surface: oil of turpentine contained in an open bottle, or even in a glass, will give a smell that is tolerable, but you would not be able to bear the same quantity of the oil dispersed on the floor. Another circumstance increases likewise the force of this smell, which is the degree of warmth in the air; the same quantity of the oil sprinkled about a room in summer and in winter will not have an equal effect.

From what we have said it follows that the quantity of oil of turpentine employed should be extended in surface as much as possible. If you would apply it on the goods themselves, which is the most simple and best way, pour some oil into a wide cup, dip lightly the end of a large pencil brush into it, and pass it forwards and backwards over the stuff till the brush is quite dry, then dip the brush again into the oil and do it over in the same manner on new places of the stuff. If you *thus* brush the oil upon goods that are

7

hanging,

hanging, you need only keep the doors and windows shut and the operation is finished.

If the goods are *taken down* there will be no inconvenience in folding them up immediately after they have been rubbed with the oil; it will be even an advantage to do it immediately, especially if after they are folded you lock them up in a close press or chest of drawers.

There is nothing else to be feared with regard to the goods from this method of applying the oil of turpentine, but that the smell might continue longer than you would chuse. When they have been well penetrated with it, you must avoid using them till they have been exposed to the air for several days.

The smell will be less *durable*, if instead of rubbing the goods themselves with the oil you only shut them up in places that have been well perfumed with it. You may, for example, rub all the inside of a chest of drawers with oil, or place pieces of paper and linnen dipt in the oil in every drawer.

Whatever hopes of utility I may have raised by the observations I have made, yet the reader, I fear, will be tired of reading only of poisons, racks, and tortures, for unhappy but industrious insects. He will be pleased no doubt to hear of the compensation I have to propose in favour of the moths. My scheme is to let them live and to get them to
work

work for us as usefully, as they have hitherto been employed to our injury. Worms furnish us with silk ; bees give us wax and honey ; we owe the lacca, so useful for sealing-wax and for varnishing, to a kind of winged ant. Our painters, and particularly painters in water-colours, may get from moths colours of all kinds and tints, by turning to their advantage a singularity we have mentioned in the preceding account of moths. It is well known that the crayons for painters are prepared with a good deal of trouble ; our moths would save us these preparations, and give us more beautiful as well as perhaps more durable colours. Their excrement has the colour of the wool, on which they have fed, and preserves intirely the lustre of it. It has the property likewise of being easily made up into a paste. In order to have a beautiful red, yellow, blue, green, or any other colour, or shades of colour, you need only feed moths with wool of each of these colours ; which may be done at a small expence by giving them only the shearings of cloths.

I must observe moreover that the moths are so teeming that whatever quantity we should want to breed for very large provisions of colours, it might very easily be obtained. The product of each moth would not be great in a whole year, but the number of insects, which might be multiplied, will give as ample a collection as our wants could require.

quire. Thus we should have, without any expence, very beautiful, and I believe very lasting colours. The good colours of our cloths are as durable as one can desire the colours of paintings to be. It is even probable that the colours, which have passed thro' the stomachs of these insects, have acquired a greater perfection, for reasons well-known by those that understand the art of dying: but after all we must wait for experience.

Memoirs 1728, pag. 139 and 311.

The rest of Mr. De Reaumur's treatises on insects, which compose six volumes in quarto, and contain a noble collection of a curious part of natural knowledge, not having been presented to the academy, do not fall within my province.

There was found in the trunk of an elm tree of the bigness of a man's body, three or four feet from the ground, and precisely in the middle, a living toad, of a moderate size, meager, and which had but just room enough to be contained there. When the timber was cloven, the toad got out and moved off very fast. No elm could be sounder, nor composed of parts more close and compacted together; and the toad could not have entered by any inlet: the egg that formed it must have been by some particular accident lodged in the tree when young: the animal had lived there

A surprising account of two toads.

there without air; and what is very surprising, had been nourished from the substance of the wood, and had grown only in proportion as the tree grew. The fact is attested by Mr. Hubert, senior, professor of philosophy at Caen, who hath writ this account to Mr. Varignon.

Mr. Seigne of Nantes hath written to the academy an account of the same fact precisely, except that instead of an elm it was an oak much bigger than the elm, which greatly increases the wonder. He judges by the time necessary for the growth of the oak, that the toad must have been preserved *there* for fourscore or an hundred years, without air or any other food than from the tree.

History 1719, pag. 39. History 1731, pag. 21.

Whether a toad will live absolutely without air I do not know, having never made the experiment with the air-pump; but it is certain he will live where there is no free communication of air; and Virgil, the correctest writer of all the ancients, with great justness observes,

Inventusque cavis bufo, Georgic. 1, 184.

I beg the reader's patience whilst I take this opportunity of remarking another instance of Virgil's delicacy in the choice of his epithets, which hath escaped the notice of commentators and critics, in the sixth book of the Æneid, ver. 107.

—Tenebrosa palus Acheronte refuso.

The

The commentators have forced upon the word *refuso* in this place a signification not its own: in short, they have given it the same sense as the word *effusus* properly bears. De la Rue in the *Delphin* edition interprets it *exundante*. By such interpretations all propriety of expression is entirely confounded. But the correct writers amongst the classics did not use words in such promiscuous senses; and I am satisfied that the word *refuso* here in *Virgil* alluded to the doctrine of *Plato* concerning the rivers of the infernal regions, delivered in his *Phædo*, edit. Serrani, tom. 1. pag. 112. There he describes these rivers as flowing from the shades to this upper world; and after having supplied the springs, rivers, &c. returning back again to those realms of darkness.

In this sense there is a very just propriety in the epithet *refusus* applied to *Acheron*; and it is certain that *Virgil* very frequently alludes to Platonic notions in the use of a single word. I need quote no other instance than that well-known passage in the sixth *Æneid*:

Ignæus est ollis vigor, & cœlestis origo
Seminibus—

The word *feminibus* all commentators allow to be an express allusion to the doctrine of *Plato*.

In like manner in the seventh *Æneid*, v. 225.

— siquem

— liquem tellus extrema *refuso*
Summovet oceano,

The Delphin edition very wildly interprets it interfuso ; and De la Cerda says, Ego capio longe, & late diffusum, atque extantum.

But the true meaning is the natural sense of the word, the ebbing ocean, to distinguish it from the Mediterranean sea, and consequently to express the remotest distance. Refuso oceano is put poëtique for oceano qui refunditur ; as inventusque cavis buso, inventus, pro qui invenitur, Servius, who rightly saw the sense of the word refusus in the seventh Æneid, and pointed it out ; but De la Rue (whose edition is so much boasted of) either did not, or could not perceive it. Thus do commentators very frequently mislead the reader, and stain the purity of classic authors by errors of their own. But I ask pardon for this long digression.

The manner of preserving eggs fresh for several years by Mr. De Reaumur.

The pleasures of life amongst the inhabitants of civilized countries, arise from an infinite number of little conveniencies and delights, that industry hath discovered by degrees the means of procuring. Not to mention all that the several arts have acquired in this kind, of how many delicious fruits should we have continued destitute in France, if we had none but those that the soil itself produced ? Like the ancient Gauls we should still sit down in ignorance and with religious awe beneath our venerable oaks.

It is almost within our own memory, that a new and excellent kind of bird, *namely* turkeys, hath been established amongst us, and hath been multiplied to such a degree, that we have almost forgot that it is a *foreigner*. Within these few years we have begun to naturalize Guinea hens, with a probability of success: what was at first the dainties of the rich, becomes at last the common food of all. Whatever can contribute to the happiness of a great number of men, how small soever the happiness may be, is an object worthy our attention. For this reason I make no scruple of pointing out a method for preserving eggs.

In the first memoir of the second volume of my history of insects I related some experiments, which prove indubitably that eggs may be preserved for several months, or even years, in the same condition as when they were laid; that an egg of several months may have as good a taste, and be as fresh, as one laid but a day.

An egg which was full when it came from the body of the hen, becomes less and less *so* as it grows stale. However compact its shell may appear to us, it is perforated by an infinite number of holes, which by their smallness escape our eye-sight, but whose existence is sufficiently demonstrated by the *void* that is made, and increases daily in the inside of the egg. A watery moisture transpires continually

tinually through those pores of the shell, and it transpires more abundantly in hot weather than in cold. You may immediately draw from an egg enough liquor to moisten its shell, you need only for that purpose put it into the pneumatic machine and pump out the air.

Now in order to preserve an egg fresh, the only point is to keep it *full* or in other words to *prevent* the transpiration; and *this* is done by stopping up the pores with a matter that cannot be dissolved by an aqueous fluid. In a word, we have proved in that memoir I mentioned before, that any varnish dissolved in spirit of wine spread over the shell, would hinder the egg from wasting. We have even entered into a detail of calculations necessary to shew that this method would not be expensive. But how little soever it may cost, and however certain the success, it will not be of use to the public, till recourse shall be had to it for preserving a very *great number* of eggs, till enough shall be varnished for supplying the continual consumption.

However *simple* the composition is of the varnish and the manner of applying it, the whole may appear too embarrassing for country people and peasants; yet *these* are the people we must put in a condition of preserving our eggs. I have always been dissatisfied with leaving *them* under a necessity of making or purchasing varnish, which is a kind of
drug

drug that they do not so much as know. But the experiments I have made *since* have informed me that one may substitute in the place of varnish a matter less dear, more known, and easy to get every where; that all hard *fat* was capable of producing the same effect as the varnish. There is no country place where they may not easily get mutton fat, and I have found that eggs, which have been *done over* with this fat, are preserved fresh as long as those which have been covered with a varnish.

The way of managing it is *this*, buy some pounds of this fat, and, that you may be sure of having it pure, melt it yourself; after having made it sufficiently liquid, strain it through a linnen cloth; let it run into an earthen pot, in which it may be kept for making use of as often as you have occasion. A pot that holds 4 or 5 pounds of the fat will contain an ample provision for a great number of eggs. Every time you would make use of it, you must put the pot before a gentle fire, and leave it *there* till the fat is become liquid again; then take away the pot from the fire, and plunge an egg into the fat, taking care that the fat touches every part of it; you need not leave it any time in the fat, for it will be sufficiently smeared in an instant; thus successively dip as many eggs as you will, and if they were fresh when you dipped them they will continue fresh for

above a year; but great care must be taken to envelop the egg with fat the very same day it was laid, and as soon as possible after it was laid.

This method of preserving eggs is particularly useful for introducing into the kingdom new kinds of birds. I have proved in the memoir already cited that as long as the egg continues in the state of a fresh egg, the embryo lives in it. The covering of fat is much more easily taken off than *one* of varnish; you may dip the egg for a moment in hot water without the embryo's suffering any mischief, as the heat, which would suffice to melt the fat, would not have the time to penetrate into the inside of the egg: but probably you may be content with *taking off* the main part of the fat by scraping and rubbing the egg, the rest will be performed by the hen that sits on it. If my notions for transporting foreign eggs and hatching them here *at home* prove true, we may have parrots in our own woods, and our tables may be spread with dainties yet unknown.

That I have recommended the hard fat for preserving eggs is only because of all substances that can be employed it is the easiest to get in all places, the cheapest, and with the least difficulty to be *taken off*: but however it is evident that any other hard matter, which will hinder the transpiration of the egg, will preserve it. I say *hard* matter, because

cause oil for example, whose parts are not closely connected together, would not sufficiently resist the efforts of the water to evaporate from the egg.

Moreover what we have said in general with regard to the preservation of eggs, may be applied to the preservation of many other substances of different sorts, which have a disposition to ferment.

Memoirs 1735, pag. 465.

Mr. Cossigny, an engineer and a correspondent of the academy, hath made in the course of his voyage to the isle of France, where he is employed, some experiments to see whether it is true, as hath been asserted, that the water penetrates into glass bottles which are plunged to the bottom of the sea. It must be supposed that *they* are well *stopped*, and those which Mr. Cossigny made use of were *so* with an extraordinary care, and as much as is possible without being *hermetically* sealed, for he could not get any of that kind.

Curious experiments on the effects of the pressure of water at different depths in the sea.

At 180 fathom, the bottle was entirely broke to pieces by the weight of so great a depth of water; and, what is still a more surprising effect, a piece of very strong cloth *done over* with pitch and tar, which covered the cork stopple, and a piece of pack-thread which bound it down tight, were reduced to shreds.

At 60 fathom, the cork stopple was carried to the bottom of the bottle, the piece of *pitched* cloth, without being perforated or torn, was sunk into the neck as far as a strong ligature would permit, and the cloth could suffer an extension without bursting. The bottle came up again almost full of water, which after having forced down the cork had penetrated through the *pitched* cloth.

At 40 fathom, the bottle came up entire; nothing of *all* that had stopped it was put out of order, nor a drop of water in the inside.

At 100 fathom, the same bottle, that had suffered nothing from the preceding experiment, came up likewise entire, but its cork, the outward end of which had been left much bigger than the neck of the bottle, that it might not be depressed, was notwithstanding sunk to the bottom of the neck, where it stopped. The *pitched* cloth was in like manner a little thrust into the beginning of the mouth, without being torn. There was at the bottom of the bottle a little spoonful of clear water. This spoonful of water was very salt, although nothing surely was wanting to make a perfect filtration.

History 1737, pag. 8.

Natural
curiosities
observed
in a
voyage to
the polar
circle, by
Mr. de
Maupertuis.

In order to determine with exactness the figure of the earth, it is necessary to compare together two degrees of the meridian the most distant in latitude that is possible; because if these degrees go *increasing* or *decreasing*

ing from the equator to the pole, the *difference* being too small between neighbouring degrees might not be distinguished from the *errors* of observations; whereas if the two degrees that are compared, are at great distances the one from the other, this *difference* being repeated as often as there are intermediate degrees, will make a *sum* too considerable to escape the observers.

The count De Maurepas sent orders to the academy from the king to determine the question concerning the figure of the earth; the academy received them with joy, and hastened to put them in execution by several of her members; some were to go beneath the equator, to measure the first degree of the meridian; others were to go to the north, to measure the most northern degree that was possible. The same ardour inspired those that were to expose themselves to the burning heats of the torrid zone, and those that were to feel the piercing horrors of the frozen clime: the same spirit animated all, the desire of being useful to their country. The persons destined for the north were four of the academy, *namely* Mess. Clairaut, Camus, le Monnier, and myself. There was in our company likewise the abbé Outhier; and we were joined by Mr. Celsius a famous professor of astronomy at Upsal, who assisted at all our operations, and whose lights and counsels were of great service to us.

Vid. map,
plate 6.

The place of our *rendezvous* was Torne. We set out from Torne on Friday the 6th of July 1736, attended by a company of Finland soldiers, and a great number of boats loaded with *instruments* and things indispensibly necessary for life. We went up the great river that rises from the remotest part of Lapland, and empties itself into the Bothnic sea, after having divided itself into two arms, that form the little island *Swentzer*, on which the city Torne is built, at 65 degrees 51 minutes latitude.

From *that* day we lived only in desarts or on the tops of mountains, which we wanted to connect by triangles. After having gone up the river from nine o'clock in the morning to nine in the evening, we arrived at *Korpikyla*, which is a hamlet on the river's side; *there* we landed, and after having walked on foot some time across the forest, we came to the *foot* of *Niwa*, a steep mountain, whose summit is nothing but a rock, up which we climbed and *there* pitched our tent. We had been upon the river very much incommoded with large flies, that have a green head, and draw blood wherever they sting; we found ourselves on the top of *Niwa* persecuted by several other sorts still more sanguinary. Two young Lapland girls were tending a little herd of rain-deer on the summit of this mountain, and we learnt from them the manner in which they protect them-

themselves from the flies in this country; the poor girls were so involved in the smoak of a great fire which they had kindled, that we could scarcely see them; but we soon enveloped ourselves with a smoak as thick as theirs.

Whilst our company was incamped upon *Niwa*, I set out from thence the 8th of July at one o'clock in the morning, accompanied by Mr. Camus, to go and make our observations on the mountains towards the north. We went up the river as far as to the *foot* of *Avafaxa*, a very high mountain; we felled the trees on its summit, and raised a signal. Our signals were hollow cones, built of several great trees, which being stript of their bark, made these signals so white that they could easily be distinguished at 10 or 12 leagues distance.

As soon as our signal was built, we descended from the top of *Avafaxa*, and having entered into the little river *Tenglio*, which throws itself into the great river at the foot of the mountain, we went up that river as far as the *place* which appeared to us the *nearest* to a mountain, that we thought proper for our operation; there we landed, and after a march of three hours across a morass, we arrived at the foot of *Horrilakero*. Although very much fatigued we got up to the top, and passed the night in cutting down the wood that was *there*. A great part of

the mountain is of a red stone with a kind of white crystals dispersed up and down, that are long and parallel one to another. The smoak could not defend us from the flies, more terrible on this mountain than on *Niwa*. It was necessary notwithstanding the heat, which was very great, to wrap our heads in *Iappmudes* (which are gowns made of the skins of the rain-deer) and to be covered with a thick rampart of fir branches and even whole trees of fir, which almost stifled us, and did not *long* secure us.

After having cut down all the trees that were on the summit of Horrilakero, and raised a signal *there*, we set out and returned by the same road to our boats, which we had drawn up into a wood; for *thus* the people of the country supply the use of cordage, with which they are ill provided. It is true, that it is not difficult to draw nor even to carry the boats which are made use of on the rivers of Lapland. Some very thin planks of fir compose a cock-boat so light and flexible, that it may strike every moment the stones, of which their rivers are full, with all the force that the torrents give it, without suffering the least damage. It is a sight terrible to those that are not used to it, to see in the midst of a cataract, which stuns you with its roaring, this weak machine hurried away by a torrent of waves, foaming, and tearing up the stones; sometimes tost into the air, and sometimes

sometimes lost amidst the billows: an intrepid Finlander steers it with a large oar, whilst two others ply with all their force the oars, to escape from the waves pursuing, and every moment threatening to overwhelm them. The keel is often aloft in air, and only rests at one end upon a wave that continually rolls away.

We re-embarked on the river *Tenglio*, and having got back into the river of *Torne* we went down it, in order to return to *Korpikyla*. At 4 leagues distance from *Avasaxa* we quitted our boats, and having marched about an hour in the forest we got to the foot of *Cuitaperi*, a very steep mountain, whose summit is nothing but a rock covered with moss; from whence the sight extends itself very far every way, and from whence you see to the south the Bothnic sea. *There* we raised our signal, and could discern from thence *Horrikero*, *Avasaxa*, *Torne*, *Niwa*, and *Kakama*.

We continued afterwards to go down the river, which hath, between *Cuitaperi* and *Korpikyla*, most frightful cataracts. The Finlanders themselves never fail to land at the place of these cataracts; but excessive fatigue had made us more disposed to pass them by boat, than to walk but an hundred paces. At last we arrived on the 11th in the evening at the mountain *Niwa*, where the rest of our company had been fixed. They had seen our signals, but the sky was so loaded with vapours

vapours that they had not been able to make any observations. I know not whether it is because the continual presence of the sun above the horizon makes the vapours to rise, and that no night *precipitates* them; but for two months, which we continued upon the mountains, the sky was always lowring, till the north wind came and dissipated the mist.

Two days after our return to *Niwa*, a very cold northerly wind having risen, we were able to make the necessary observations.

On the 14th we quitted *Niwa*, and whilst Mess. Camus, le Monnier, and Celsius went to *Kakama*, we came Mess. Clairaut, Outhier, and myself to the top of *Cuitaperi*, from whence the abbé Outhier set out on the 16th to go and plant a signal upon *Pullingi*. We made on the 18th some observations, which though interrupted by thunder and rain were finished that evening: and on the 20th we set out from thence, and arrived at midnight to the top of *Avasaxa*.

This mountain is at 15 leagues distance from Torne, on the edge of the river; the access is not easy, you go up it through a forest, which reaches about half way its height; *there* the forest is interrupted by great heaps of steep and slippery stones; after which you find the forest again, which did extend itself quite to the top; I say, *did extend itself*, because we had felled the trees that covered the top. The north side of it is a frightful precipice

precipice of rocks, in which some hawks had made their nests; it is at the foot of this precipice that the *Tenglio* runs, which winds round the *Avasaxa*, before it throws itself into the river of *Torne*.

From this mountain the view is extremely beautiful; no object confines the sight towards the south, and you discern a vast extent of the river; towards the east the eye pursues the *Tenglio* into several lakes, through which it passes; on the north side the sight extends to 12 or 15 leagues, and is terminated by a vast heap of mountains piled one upon another, in all the confusion of a chaos.

We continued ten days on this mountain, during which *curiosity* procured us visits from the inhabitants of the neighbouring country; they brought us fish, sheep, and the wretched fruits that grow in those forests.

I set out from thence for *Pullingi* in company with Mess. le Monnier, Outhier, and Celsius. The same day that we quitted *Avasaxa*, we passed the polar circle, and arrived the next day the 31st of July about 3 o'clock in the morning at *Turtula*, which is a kind of hamlet, and where they were cutting the little barley and hay that grows there. After having marched some time in a forest, we embarked on a lake that brought us to the foot of *Pullingi*.

This is the highest of all our mountains, and its access very difficult by the suddenness
of

of its ascent and by the height of the mofs, through which we had great fatigue to make our way. We arrived however on the summit at 6 o'clock in the morning; and our residence *there* from the 31st of July to the 6th of August was as toilsome as the ascent to it. We were obliged to cut down a whole forest of large trees, and the flies tormented us to such a degree, that our soldiers, who were a distinguished troop even in Sweden (where there are so many brave ones) those men that had been hardened by the greatest toils were obliged to wrap their faces up in linnen; these insects infected every thing we wanted to eat, in an instant all our provisions were blackened by them: birds of prey half famished kept fluttering round about us, in order to snatch away some pieces of mutton as we were dressing it.

The next day after our arrival on *Pullingi*, the abbé Outhier set out from thence with an officer of our soldiers to go and raise a signal towards *Pello*. On the 4th we saw a signal appear upon *Niemi*, which was put up by the officer; having taken the angles between these signals we quitted *Pullingi* the 6th, in order to go to *Pello*; and after having gone up four cataracts we arrived *there* the same day.

Pello is a village inhabited by some Finlanders, near which is *Kittis* the least of all our mountains; *there* we raised our signal.

In

In going up this mountain we find a large spring of the clearest water, that issues from a very fine sand, and in the greatest cold of winter preserves its liquidness. When we returned to *Pello* towards the end of winter, whilst the sea of the Bothnic gulf, and all the rivers, were as hard as marble, this water flowed as in the summer.

We were lucky enough to make our observations as soon as we arrived, and to continue upon *Kittis* no longer than the next day: we set out from *thence* at 3 o'clock in the afternoon, and arrived the same evening at *Turtula*.

For a whole month we had been inhabiting deserts and the tops of mountains, where we had no other bed than the ground, or a hard rock, covered with the skin of a reindeer, and scarce any other food than some fish that the Finlanders brought us, or which we caught ourselves, with some sorts of berries and wild fruits that grow in those forests. Mr. le Monnier, whose health declined visibly every day by this kind of life, and who had received very severe attacks upon *Pulangi*, being unable to support it any longer, returned down the river, to go and recover himself at the house of the clergyman of Ofwer-Tornea, whose house was the best, and almost the only refuge in the country.

I set out at the same time from *Turtula*, accompanied by Mess. Outhier and Celsius, to
go

go across the forest and find the signal that the officer had raised upon *Niemi*. This voyage was terrible; we *walked* at first, in leaving *Turtula*, as far as to a rivulet, where we took water in three little boats; but they navigated with so much difficulty amongst the stones, that we were obliged every moment to get out and leap from stone to stone. This rivulet brought us to a lake so full of little yellowish grains, of the size of millet, that all the water was coloured by them. I took these grains for the *chrysalis* of some insect, and should imagine that it was of some of those flies that persecuted us. At the end of this lake, it was necessary to *walk* to another; that had the most charming transparent water, upon which we found a boat; we put into it the quadrant, and followed it on foot along the side of the lake. The forest was so thick on the sides, that it was necessary to make ourselves a passage with an hatchet, embarrassed at each step with the height of the moss, and with the firrs that we found lying along in our way. In all these forests there are almost as many of these trees lying as standing; the earth, which can let them grow to a certain point, is neither capable of nourishing them, nor deep enough to let them take a firm root, one half of them decay, or fall by the least blast of wind. The forests are every where full of firrs and birch-trees *thus* rooted up; time hath reduced the

the birch-trees to a perfect *dust*, without having caused the least alteration in the *bark*; and one is surpris'd to find many of these trees that are pretty big fall to pieces by a touch. It is perhaps this *durableness* of the bark of birch-trees that gave the thought of making use of it for covering houses; nothing could be more proper for this purpose. In some provinces this bark is covered with earth, which forms on the roof a kind of garden: there are some of these gardens on the houses of *Upsal*.

After much fatigue in passing through this forest strewed with ruins, we at last arrived on the border of a third lake, very large, and whose water was the most beautiful crystal in the world. We found *there* two boats, in which having put our instruments and baggage, we waited for their return on the border of the lake. The high wind, and the bad condition of the boats, made the voyage very long: however they returned, we went on board them, crossed the lake, and arrived at the foot of *Niemi* at three o'clock in the afternoon.

This mountain, to which the surrounding lakes and all the difficulties we under-went had given the air of an *enchanted* place, would have been charming every where else but in Lapland; on one side a *wood* quite free from thickets, and the ground as smooth as the walks of a garden; the trees affording
shade,

shade, and not intercepting the view of the lake, that washes the foot of the mountain; on another side you see spacious rooms and retired grottos, that appear cut into the rock, but are open at the top: these rocks are so perpendicular to the horizon, so lofty and so even, that they seem rather the walls of a palace which is going to be built, than the rough workmanship of nature. We saw several times those vapours rise from the lake, which the people of the country call *Haltios* and which they take for *spirits* that are the guardians of mountains. This mountain was formidable on account of the bears, that we were told we should find *there*; but however we saw none, and indeed it hath more the appearance of a mountain inhabited by fairies and *genii*, than by bears.

The next day after our arrival the *fogs* prevented our observations. On the 10th our observations were interrupted by thunder and rain; the 11th we completed them; having left *Niemi*, after repassing the three lakes we arrived at *Turtula* at nine in the evening. We departed from thence the 12th, and came to the clergyman's house at *Ofwer-Tornea* about 3 o'clock in the afternoon.

I set out the 13th with Mess. Clairaut, Camus, and Celsius, for *Horrilakero*. We went up the *Tenglio* in four boats; this river hath its cataracts more troublesome on account of the shallowness of its water and the
great

great number of stones, than for the rapidity of its stream. I was surprised to find on its borders, so near the frozen zone, as beautifully blushing roses as grow in our own gardens. We arrived at nine in the evening at *Horrilakero*. Our observations were not finished *there* till the 17th: and having set out from thence the next day we arrived in the evening at *Ofwer-Tornea*, where we all met together.

The most convenient place had been chosen for our *basis*. But going up in the evening to the top of *Avasaxa*, to observe the angles that were to connect this basis to our *triangles*, we saw *Horrilakero* all on fire. This is an accident that often happens in these forests, where there is no living in the summer but in smoak, and where the moss and firs are so combustible, that very often the fire catches and spreads itself over some thousands of acres, so that the whole country appears in a vast blaze of flames, or is involved in a thick night of smoak.

As the fire of *Horrilakero* arose no doubt from the fire we had left *there* not well extinguished, we sent away 30 men to stop the flames by cutting off all communication with the neighbouring woods. Our observations at *Avasaxa* were not finished till the 21st. *Horrilakero* still continued burning; It was quite darkened with smoak; and the fire that had descended into the forests below was

continually making new ravages. Some of our people having brought word that our signal at *Horrilakero* had been damaged by the fire, we sent to repair it.

On the 26th of August having heard that our sector, which we expected from England, was arrived at Torne, we hastened *thither* to get this sector and all the other instruments which we were to carry up to the top of *Kittis*; because, as the severity of the winter was more to be feared upon *Kittis* than at Torne, we were willing to begin our observations for the amplitude of the arc at this extremity of our meridian, before the violent frosts should come on.

We set out from Torne the 3d of September with 15 boats, which made upon the river the greatest fleet that ever had been seen *there*: we arrived the 9th at *Pello*, where we all met together.

Our frequent journeys forwards and backwards, during our abode of 63 days amidst the desarts, had furnished us with the most beautiful series of triangles that we could possibly desire. A work begun without knowing whether it would be feasible, and, as I may say, at hap hazard, was become entirely successful; in which it seemed as if we had been able to place mountains agreeably to our own fancy.

It was on Friday the 21st of December, the day of the winter solstice, a day remarkable

able for such a kind of work, that we began the measure of our basis towards *Avasaxa*, where it lay. The sun at that time of the year, did but just rise above the horizon about noon; but the long twilights, the whiteness of the snow, and the *lights* with which the sky is always illuminated in those countries, gave us every day sufficient light for working four or five hours.

We set out at 11 o'clock in the morning from the clergyman's house at *Ofwer-Tornea*, where we lodged during this whole operation; we went upon the river, where we were to begin the measure, with such a number of sledges (called *trâneaux*) and with so great an equipage, that the Laplanders came down from their mountains, attracted by the novelty of the sight. I shall say nothing of the fatigues and dangers of this operation; the reader will easily imagine what it must be to march in snow two feet deep, loaded with heavy poles, which we must continually lay down upon the snow and lift up again; and *this* during a frost so violent, that the tongue and lips froze instantly to the brim of the cup and could not be separated without tearing off the skin, when we took a little brandy, which was the only liquor we could keep from freezing. Whilst the extremities of our body were dead with cold, the toil made us *sweat* in the rest of our body. Brandy was not sufficient to quench our thirst, it was necessary

to dig in the ice deep wells, which were no sooner opened than they cruſted over again, and we could ſcarce get the water faſt enough to our mouths to be *ſtill* liquid. Beſides all this we run great riſk of having mortifications enſue from our limbs being frozen.

Our work however advanced very happily; ſix days labour had brought it ſo far, that there remained no more to meaſure than about 500 fathom, which we had not been able to plant with ſtakes ſo ſoon as we wanted. Our meaſuring therefore was interrupted the 27th, and Meſſ. Clairaut, Camus, and le Monnier went to plant theſe ſtakes: in the mean time, the abbé Outhier and I employed this day in a very extraordinary adventure.

An obſervation of the ſlighteſt conſequence had been forgot in the ſummer; we had neglected to take the height of a certain object, which we had made uſe of on the top of *Avafaxa*, in taking the angle between *Cu-itaperi* and *Horrilakero*. The deſire we had that nothing ſhould be defective in our work, made us carry our exactneſs to a ſcrupulous nicety. I undertook therefore to get to the top of *Avafaxa* with a quadrant.

Let the reader imagine to himſelf a mountain extremely high, full of rocks, that were now concealed from the ſight by the prodigious quantity of ſnow, which likewiſe covered the *bollores* where one might eaſily be ſwallowed up, and he will ſhudder at the thoughts

thoughts of mounting such a precipice amidst such horrors. There are however two ways of accomplishing it; the *one* by marching or rather sliding on two narrow planks about 8 feet long, which the Finlanders and Laplanders make use of, to prevent their sinking into the snow; but it is a manner of travelling that requires long exercise to be able to perform it. The *other* method is by trusting yourself to the rein-deer.

These animals can draw but a very little boat, which will scarce admit the half of a man's body; this boat which is made for navigating in snow, in order to meet with less resistance from the snow which it must cleave with its prow, and on which likewise it must slide, hath a *pointed* prow and a *narrow* keel; which indangers its rolling and overturning continually, if he that is within it is not very attentive to preserve the equilibrium. The boat is fastened by a thong to a breast-leather of the rein-deer, who runs with fury upon a beaten and solid road. If you want to stop him, it is to no purpose to pull a kind of bridle that is fastened to his horns; intractable and untamable he only changes perhaps his road; sometimes he runs back and revenges himself by kicking up behind. In that case the Laplanders have the dexterity to throw their boat over them, and make use of it as a buckler against the fury of the rein-deer. As for us, who were not capable

of this dexterity, we should have been killed before we could have put ourselves in a condition of defence. All our guard was a little stick which was put into our hands, and which we made use of as a rudder to steer the boat, and to avoid the trunks of trees. In this manner committing myself to the reindeer I ventured to mount *Avafaxa*, accompanied by the abbé Outhier, two Laplanders, a Lapland woman, and Mr. Brunnius the clergyman. The first part of the journey was performed in an instant; there was an hard and beaten road from the clergyman's house to the foot of the mountain; the reindeer went it with a swiftness exceeding *that* of any *other* four-footed animal, and can be compared to nothing but the flight of a bird.

*Ocior cervis, et agente nimbos
Ocior euro.*

Altho' the mountain, up which there was no track, retarded the rapidity of the reindeer, they conveyed us quite to the summit; and we quickly made the observation, for which we went. In the mean time the reindeer made deep holes in the snow, and fed upon moss, with which the rocks of that mountain are covered. The Laplanders that accompanied me had kindled a great fire, to which we soon came to warm ourselves along with them. The cold was so great that the heat of the fire could not extend itself to the
least

least distance; if the snow melted in the places that were touched by the fire, it froze again all round, and formed an icy hearth.

We now were under another terror, of falling down headlong in our return from this craggy mountain, drawn in vehicles by animals that were ungovernable, even on a plain; but not to detain the reader with the horrors that are too great to be described, we were brought down in an instant to the foot of Avasaxa, traversed the great river, and in a moment arrived at the house.

The next day we completed the measuring our basis; and we had no reason to repent the difficulties we had undergone in performing such a work on a river that was frozen, when we perceived the *exactness* that our measuring upon ice had afforded us: we had divided ourselves into two companies and made two separate measurings; the difference between the two measures was no more than 4 inches upon a distance of 7406 fathom and 5 feet; an exactness that we could not hope to find, and scarce dare to relate.

After this operation we made haste to get to Torne, that we might shelter ourselves from the severity of the winter.

The city of Torne, at our arrival the 30th of December, had truly a frightful appearance; its low houses were sunk quite to the roof in snow, which, had there been any day-light, must have hindered the entrance

of it by the windows : but the snow continually falling or hanging in the air, scarce ever permitted the sun to appear, for the few moments he is above their horizon about noon.

The cold was so great in the month of January, that our mercurial thermometers of Mr. De Reaumur's construction, those thermometers which we had been surprised to see fall to 14 degrees below the freezing point at Paris in the greatest frost of the severe winter in 1709, now fell 37 degrees below it; the thermometers with spirit of wine were frozen. When one opened the door of a warm chamber, the cold air from without immediately turned into snow the vapour that arose from the breath of persons in the room, and formed large and white flakes. When you went into the open air, it seemed to rend the breast asunder. We were threatened every moment with an increase of cold by the cracks and splittings of the timber, of which all the houses in that city are built. To see the desolateness in the streets, you would have thought all the inhabitants of the place were dead. One frequently sees in Torne people maimed of a limb, an arm, or a leg, by the cold.

The cold, though always great in these countries, yet often of a sudden increases so much as to be fatal to those who are exposed to it; sometimes there rises all at once a tempest

pest of snow, which is still more dangerous ; the wind seems to blow from all quarters of the sky at once, and drives the snow with such impetuosity, that in a moment all the roads are lost from your sight. Whoever is caught in such a storm in the country, would in vain hope to find his way by his knowledge of places, or by marks he had made of trees, &c. he is blinded by the snow, and is in danger of being swallowed up in some pit if he offers to stir a step.

Although the earth appears dreadful at this season of the year in these climates, yet the sky presents you with one of the most charming sights in the world. As soon as the long nights begin, you see the sky illuminated by lights of a thousand shapes and colours, that seem designedly to make this climate amends for the absence of the sun. These lights in this country have no constant situation, as they have in our southern countries : although you may often see a *luminous arch* fixed towards the north, yet they seem most commonly to possess the whole extent of the hemisphere : they begin sometimes by forming a kind of mantle of a bright and moving light, which hath its extremities in the horizon, and spreads itself rapidly thro' the sky, with a motion resembling *that* of the drag-net of fishermen, preserving in this motion very perceptibly a perpendicular direction to the meridian. Most commonly
after

after these preludes, all these lights come and unite together towards the zenith, where they form the summit of a sort of crown.

The *figures* these lights assume, and their *motions*, are so various, that it is impossible to enumerate them : but their most common motion makes them resemble military *colours* waving in the air ; and by their different tints of colours one would take them for so many *streamers* of a *changeable* taffety ; sometimes they line some parts of the sky with scarlet. I saw one day at *Ofwer-Tornea* (it was on the 18th of December) a sight of this kind, which engaged my admiration, notwithstanding my being so long accustomed to wonders. I saw towards the south a large region of the sky coloured with so lively a red, that it seemed as if all the constellation of orion was bathed in blood. This *light*, fixed at first, began very soon to move ; and after having taken other colours, violet and blue, it formed a *dome*, the summit of which was a little inclined to the south-west of the zenith ; an extremely bright moon-light did not in the least efface any thing of this sight. I never saw but two of these *red* lights, which are rare in this country, *where* there is such abundance of so many other colours. Whenever *they* are seen, the people apprehend some direful disaster. No wonder that *those* who look at them with other eyes, than philosophic sight, should perceive flaming chariots,

1911

1882

48 The ...

1911

1895

1945

1990

riots, fighting armies, and a thousand other prodigies !

In the month of May, whilst ice still continued on the river, the sun had approached so near us that he scarce sunk beneath the horizon ; it was a singular sight to see him *so long* enlighten an horizon that was covered with frost, to see, as I may say, *summer* in the sky, whilst *winter* was on earth. We were then in the morning of that great day which continues several months, yet it did not appear that the constant sun caused any change in our frost and snow. On the 6th of May it began to rain, and we saw some water on the ice of the river. Every day at noon the snow dissolved, and in the evening the cold fast bound it up again. At length, on the 10th of May, we saw the *earth* which had been so long concealed from our sight : some elevated points of land, that were exposed to the sun, began to appear ; and I could not forbear comparing this view to the assuaging of the waters after the flood, when *the tops of the mountains were seen*. Soon after, the birds began to warble, and all the face of nature broke into smiles of joy.

Memoirs 1737, pag. 390.

N. B. *I have not troubled the reader with the detail of mathematical operations in the process of their work, nor with the astronomical tables and observations ; it*
is

is sufficient to remark that they all concurred to the immortal glory of Sir Isaac Newton, and to the establishment of his theory concerning the flatness of the earth towards the poles.

Observations of natural curiosities at Peru, by Mr. Bouguer.

The persons destined for the voyage to Peru, in order to determine the figure of the earth, were three of the academy, Mr. Godin, Mr. de la Condamine, and myself; Mr. de Jussieu, who hath since our departure been made a member of the academy, was joined to us, and appointed particularly to attend to the natural history of the countries through which we should pass; which task he hath executed with great care. A great many others were assigned assistants to us for making drawings, for calculations, and for discovering countries.

We embarked the 16th of May 1735 in the road of Rochelle aboard a man of war. After a pretty long stay at St. Domingo, we set out from thence the 30th of October for Carthagena. From thence we went to Portobello, and having travelled across the isthmus, we embarked at Panama on the South-sea, and arrived on the coast of Peru the 9th of March 1736, casting anchor in the road of Manta. Here Mr. de la Condamine and I separated from the rest of the company, because we thought we might make good use of our time in this part of the coast, where
the

the heavy rains had already ceased ; whereas we were told that they would continue, yet a good while, *further* towards the south, and that the road of Quito would be unpassable till the month of June.

Mr. Godin set sail again with the rest of the company to go and land at Guayaquil. We had no reason to repent the choice we had made of landing *here* ; it gave us the opportunity of getting a perfect knowledge of this coast, which being the most westerly of all South America was necessary to be known with a particular exactness.

This country cannot fail of being extremely hot, since it is on a level with the sea, and placed in the midst of the torrid zone ; it hath forty or forty-five leagues breadth, which is the distance of the Cordilleras (or Andes) from the sea. Sometimes the coast changes suddenly its direction, and as if the chain of mountains had perceived the shifting trick, although at so great a distance, they seem to humour and conform themselves to it ; but most commonly they run in a straight line, insomuch that they are at a less distance from the sea, when some gulf, such as *that* of Guayaquil for example, enters considerably within land. Beyond this last mentioned gulf in going to the south towards Lima, the country is quite different ; you find nothing but sands, which the sea seems to have deposited *there*, or to which one might give a quite

quite contrary origin, by supposing that they have fallen from the Cordilleras ; the country is entirely bare, no wood grows on it as on this side the gulf : but what distinguishes still more this part of Peru which is beyond Guayaquil is, that it never rains *there*, although the sky is very often cloudy. This particularity gives rise to a problem in physics, which is by so much the more embarrassing, as its solution depends on a more perfect knowledge of the nature of clouds, than the world at present hath : but it would be necessary to take up things at their very source, in order to give all the clearness necessary to the explication of this phenomenon. The narrow bounds within which I am obliged to confine this public recital, oblige me to defer my observations upon it to another opportunity.

After having made divers excursions in this country, which is so little inhabited that the villages of Indians or Spaniards are often fifteen or twenty leagues distant from each other, and sometimes a great deal more, it was necessary to think of making the best of our way to Quito, the roads of which began to be passable by the cessation of rains.

Mr. De la Condamine and I agreed to take different roads, that we might enlarge our remarks ; we were then at the mouth of a river called *Rio-Jama* which is no more than nine minutes distant from the equator in the southern

southern latitude, and is almost on the same parallel as Quito. Mr. De la Condamine pursued the coast in going by sea northward quite to the mouth of the river of Emeralds, which he went up and made a map of the whole country, but it was with great labour and difficulty that he went across it. I directed my course in the mean time southward in order to go to Guayaquil, penetrating through forests, the ground of which was still so drowned with water, that I had often water quite up to my knees when mounted upon the tallest horse: it was nothing but a morass or a continual slough; the violent efforts that the mules made to disengage themselves exposed the rider every moment to be dashed against trees: the same thing happens in most of the places of the torrid zone, where there are woods.

This country would soon be fuller of tigers than of men, had not providence kindly taken care that all very mischievous animals should not multiply much; the tigers therefore are but few in number; indeed one or two of them is enough to make desolate a whole province.

N. B. *This agrees with a fine observation of Herodotus, that* " Divine wisdom and providence hath made all such animals as are of a timorous heart and fit for food to be extremely teeming, but on the contrary such

" as

“ as are savage and malignant to produce but few.” He gives for examples, the hare, which he says is the only animal of the wild kind that admits of a superfetation; and, the lioness, which he says produces but once in her life, and never more than one. Lib. 3. cap. 108, edit. Gronov.

It is surprising that Aristotle on the contrary should assert in his sixth book of the history of animals, that the lioness produces every year in the spring, commonly two at a birth, but never more than six; and that in Syria the lioness produces five times in her life, at the first five at a birth, and every year after she lessens one. When she hath completed her five times, she becomes barren. Pliny hath followed Aristotle in this strange account. But nature herself confutes these naturalists; for as Mr. Bouguer observes, and Herodotus before him, that if such mischievous animals were thus prolific, it would have been impossible for man to live. I cannot help observing likewise that Aristotle superciliously sneers Herodotus for the natural reason he assigns, why the lioness produces but once. I do not know whether any of the commentators on Aristotle have taken notice of it, but it is evident I think from the expression, that Herodotus was the person levelled at. Vid. Aristotle's hist. animal, lib. vi. cap. xxxi.

Serpents likewise are common in this country, as in most other hot countries, and several sorts of them are extremely dangerous.

The

The houses in general are built with nothing but reeds, and are almost always raised upon stakes, seven or eight feet high. This precaution doth not prevent things from tainting very soon and putrefying, the moisture being continually aided and rendered more active by the heat.

As soon as I arrived at Guayaquil, I set out from thence on the same day, and going up the river of the same name came the 19th of May to Caracol, which is at the foot of the Cordilleras, three days after that Mr. Godin had departed in order to pass the mountains. He had made use of almost all the mules of the province, altho' he had left behind him at Caracol near a fifth part of our equipage, because it is necessary on account of the difficulty of the roads to make our luggage as light as possible. He continued his march and arrived at Quito with the rest of the company on the 29th of May, a year and a few days after our departure from Europe.

I could not get thither till the 10th of June; I had been obliged to wait at Caracol for want of a proper conveyance, and my health was greatly impaired by the fatigues I had undergone in coming from Rio-Jama, but principally from Puerto-Viejo to Guayaquil; I set out however in my turn to pass the chain of mountains that were before me. I spent seven days in performing this journey,

VOL. I. U altho'

altho' I reckon it no more than eight or nine leagues to cross them ; but the ascent is extremely rugged, and interrupted by an infinite number of precipices ; on the brink of which you are obliged to march ; you pass several times a little river called *Ojiva*, where several persons every year lose their lives ; it is a torrent, whose rapidity is amazing, altho' its channel is pretty wide. Even when you have passed it for the last time, and are going from it, you cannot help being still in a fright, the noise pursuing you keeps fresh the apprehension of dangers you have escaped. Sometimes you go down a *descent* ; you meet with a deep hollow that is with difficulty passed, and spend the rest of a day in going up only on the other side, where you find that you are but at a very little distance from the place you set out at in the morning.

The fatigue of the mules is so great, that after they have taken seven or eight steps you must let them rest and take breath ; thus the whole march is nothing but a succession of stoppings, and movings that are very slow, altho' made with the greatest toil. The rain was so violent and every thing so wet the first days of our journey, that we were not able to kindle a fire ; we were therefore obliged to live on bad cheese and biscuit. My people got me every evening the best lodging they could, made of the branches and leaves of trees, unless by chance we found an hut already
ready

ready made by some other traveller. I marched *thus* seven days, in which I do not include the time I passed in a little town called Guaranda, which is imbosomed in the Cordilleras, and offers you a place of repose that no one fails to take advantage of. At last I got to the foot of a very high mountain, named Chimborazo, which is continually covered with snow, and all the ground was frozen and icy. The Cordilleras being nothing but a long range of mountains, whose summits vanish from the sight amidst the clouds, there is no possibility of crossing them but by narrow passages. That pass by which I penetrated gave sufficient marks of its great elevation above the level of the sea: I was but at the foot of Chimborazo and yet found myself already in a region where it never rains, I saw nothing round me to a very great distance but snow and hoar-frosts.

I had been following exactly the track of an old troop of Spaniards, the memory of which hath been transmitted to us by historians. This troop was commanded by Don Pedro Alvarado, when in the first years of the conquest of Peru, and precisely two hundred years before me, he made this same passage in order to convey a considerable reinforcement to Francis Pizarre. He went from Puerto-Viejo to Guayaquil, passing through Jipijapa, as I have done; from Guayaquil he went up to the foot of Chimborazo, and passed

fed by the south side of that mountain in order to go to Riobamba, the name of which was *then* Rivecpampa; but in passing over a hill, which must necessarily be the same as is now called the *Arenal*, seventy of his people, who knew nothing of Peru but the fame of its riches, and had taken no precautions, perished with the cold and the fatigue, and amongst them were two or three the first Spanish women that had the courage to enter this country.

As soon as I was arrived at the top, I was obliged to descend, but was struck with amazement at the novelty of the sight; after having been successively exposed to the burning heat of the torrid zone and to the shivering cold of the frozen, I could not help fancying myself of a sudden transported into one of the most temperate climates; I thought I breathed the air of France, and saw her delightful fields adorned with all the beauty of the spring.

I discerned at a distance lands extremely well cultivated, a great number of towns and villages inhabited by Spaniards or by Indians, delightful country seats, and in short the whole country, which is free from woods, as much peopled as some of our provinces. The houses were no longer made of reeds, but solidly built, sometimes of stone, and most commonly of large bricks dried in the shade. Each village is constantly adorned with a very
large

large square, a part of one of its sides is occupied by the church, from the square *open* streets or roads, that run in a straight line and terminate at a vast distance in the country: oftentimes likewise the fields are cut in the same manner by these roads at right angles, which gives them the appearance of a large garden. Such is that part of the province of *Quito*, which is situated in the Cordilleras to the north and south of that *capital*; it deserves this title on account of its grandeur, its edifices, and the multitude of its inhabitants.

The city is near a mile in length and more than half a mile in breadth; it is the see of a bishop, the place of residence for the president of a court of judicature, who is at the same time governor of the province; it hath a great number of religious convents, and two colleges, which are two different kinds of universities, the one under the direction of jesuits, the other of dominicans. The city contains thirty or forty thousand inhabitants, of whom more than a third are Spaniards or of Spanish extraction. Commodities are not extremely dear *there*; foreign manufactures alone (which it is even difficult to convey thither) bear an excessive price, such for instance are our linnens, cloths, and silks: but the country itself supplies abundantly all the necessaries of life.

The richness of this country is owing to its being inclosed by the Cordilleras in a double range of mountains, which, like two walls, separate it on the east and the west from the rest of America. The first of the two chains of mountains is at forty or forty-five leagues distance from the sea, as I have already mentioned; the two ranges run parallel to each other, at seven or eight leagues distance; I mean their summits: sometimes they spread more widely, sometimes draw nearer to each other, but always follow pretty nearly the same direction, which doth not differ much from *that* of the meridian. Their great nearness occasions the land that lies between, which hath five or six leagues of breadth, to be extremely high, and makes the two chains of mountains, which are so distinct to the inhabitants *within*, appear to those that are *without* to form one single mass. Quito, and the greatest part of its province, is situated thus in a long valley, which can only not be dignified with the name of mountain, because it is placed between mountains that are above it, and whose tops are covered with snow. The Cordilleras are not *double* throughout the whole length; they are *so* for the space of an hundred and seventy leagues, that I have travelled from the south of Cuenca to the north of Popayan, and I know that they continue *double* still farther to the north, although the country

country loses by degrees, *in sinking too low*, the good qualities which it hath about Quito.

The sufficient breadth of this valley, and its situation with regard to the sun, must naturally make the heat insupportable; but on the other hand, the vast height of the ground and the nearness of the snow must temperate the heat; the two contraries blend together, and their alliance must produce an autumn or a continual spring. The thermometer of Mr. De Reaumur keeps *there* at 14 or 15 degrees; the fields are always green; you have *there* all the fruits of the torrid zone, as well as *those* of Europe that have been brought thither, such as apples, pears, and peaches; the trees are almost always in sap; all the different sorts of grain, and particularly wheat, thrive extremely well: they might likewise have wine, if Lima had not got an exclusive privilege for making it one of the branches of her commerce, whilst Quito subsists on her own commodities, and by her manufactures of cloths and cotton stuffs. In short, you need but chuse a situation a little higher or a little lower, (for it must be imagined that this long valley doth not make a continued level) in order to enjoy the air and pleasures of the most different climates.

The day *there* is always pretty near equal to the night; it is a perpetual equinox; and the degree of temperature in the same place

is likewise pretty near the same through the whole year ; it is the rain alone that distinguishes the seasons ; the rains fall from the month of November to the month of May. These rains, together with earthquakes and frequent eruptions of vulcanos, cause the bad qualities of the country, which balance in some measure the good ones we have mentioned.

As the inhabitants of Quito live in the highest region of the known world, and breathe an air that is thinner by *a third* than the rest of mankind, we found ourselves at first considerably incommoded by the thinness of the air ; those amongst us that had weak lungs, perceived the difference more, and were subject to little hemorrhagies ; which proceeded no doubt from hence, that the atmosphere, having a less weight, did not aid sufficiently by its compression the vessels in retaining the blood, which continued to have the same power of distending them. For my own part I did not observe that the uneasy sensation from the thinness of the air increased much, when we were obliged afterwards to mount higher than Quito, perhaps because I was *new* fashioned to the country ; or perhaps because the cold, as one mounts higher, hinders the dilatation of the air from being so considerable as it would otherwise be.

Several amongst us in ascending up higher fainted away, and were subject to vomitings ;
but

but these accidents were rather the effect of fatigue, than of the difficulty of respiration ; what proves it in an incontestable manner is, that we were never exposed to them when we mounted on horseback, or when we were once got to the top, where the air however was still more subtile. I do not deny but the thinness of the air might increase the lassitude, and contribute to exhaust the spirits, for respiration became more difficult upon the least action, and we found ourselves quite out of breath by the least motion ; but it was not so, when we continued at rest and inactive.

N. B. *These effects that Mr. Bouguer attributes to fatigue and lassitude, and which ceased when they mounted up on horseback, seem rather owing to this, that the impetus of the blood upon the vessels is much less when a man is carried by a gentle motion on horse-back, than when he climbs up a hill by his own force. The increased impetus of the blood in such violent motion, whilst the air that should compress the vessels is become thinner, by distending the vessels or villi of the stomach, may occasion vomiting, or even vomiting of blood ; and such an affection of the stomach by a sudden derivation of blood from the brain, may probably occasion a lipotbymy : which symptom perhaps led Mr. Bouguer into the mistake of attributing it to fatigue, whereas ten times the fatigue would*
not

not have such an effect upon hardy men, that had now been long accustomed to fatigues.

What confirms the opinion I have given, that these effects were owing to the impetus of the blood being greater in walking than in riding, is the observation which Mr. Bouguer makes, that respiration was difficult upon the least action, or by the least motion: now the least action or motion could not occasion lassitude, and consequently the shortness of breath must have some other cause, which I think could be no other than the increased momentum of the blood, whilst the pressure of the air, and consequently the resistance of the vessels, was so greatly diminished.

The reason that horses and other cattle are not in like manner affected, is probably the same as prevents the inhabitants of Quito from feeling any of those uneasy sensations, which were perceived by our Europeans, namely, that they are naturally accustomed to that air.

Quito is at the foot of those mountains, named Pichincha, which belong to the western chain of the Cordilleras, or that which is to the side of the South-sea; you mount up on horse-back to a great height, as you do up the greatest part of the others. Several of these mountains resemble one another in this, that their foot is composed of divers hills consisting of a whitish clay or common earth, which produces grass, and that from the
middle

middle there rises up an high pyramid or mass of stones. It is probable that *earth* covered the whole in times past, but that crumbling away by little and little, or tumbling down suddenly by some earthquake, it made the rock lie bare and open. It is very difficult to mount this part of Pichincha. We spent three weeks upon its summit; the cold *there* was so extremely sharp, that some amongst us began to feel scorbutic complaints, and the Indians and other domestics that we had taken in the country had violent gripes; they voided blood, and some of them were obliged to go down again from the mountain. But this indisposition, when we were arrived at the top, proceeded only from the severity of the cold, to which they had not been accustomed; and the dilatation of the air did not appear to be the cause, at least the immediate or proximate cause of it. This I examined with so much the more care, as I had reason to think that the greatest part of travellers had been deceived in it, by not distinguishing sufficiently the different effects. Oftentimes in the evening, whilst we were at supper, we had *placed* in the midst of us an earthen pan full of fire, with several wax lights and candles burning, and the door of our tent or hut was shut with double leathers; but notwithstanding all *that* the water froze in our glasses. We had the utmost difficulty to regulate a pendulum clock; we were almost

almost continually enveloped with clouds; sometimes the weather changed three or four times in half an hour; a tempest was succeeded by a serene sky, and in a moment *after* we should be stunned with a clap of thunder, by so much the louder as it was extremely near us. In short, our mountain was with respect to storms and tempests in the same situation as a rock in the sea, against which the waves continually dash and break. We had a thermometer brought to us towards the end of our abode *there*, but it was not till we thought the cold a little abated. This thermometer, which was one of Mr. de Reaumur's construction, varied *there* much more than it had done below at Quito, or on the sea-side. It often varied from the morning to the afternoon 17 degrees, altho' we kept it always in the shade.

The mercury in the barometer, which was on the sea-shore at 28 inches 1 line, rose *here* no higher than 15 inches 11 lines; the elasticity of the air was exactly proportionate to its condensation, in the same manner as it was on the sea-shore, and hath been constantly observed in Europe.

We had frequent opportunities of observing how much some philosophers have been deceived in thinking, that *clouds* are of a different nature from *fogs*. Oftentimes the clouds did not reach so high, but we saw them five or six hundred fathom below us; they

they prevented us from seeing the *earth*, whilst they darkened the *sky* to the inhabitants of *Quito*. At other times these clouds were less heavy, they mounted up higher, and were with respect to us a mere fog, although the observers below had still the same reason to consider them as clouds. When I have looked at them very much below us, they have always appeared to me extremely white; I cannot give a better representation of them, both with respect to the colour and figure they had to my eye in that situation, than by comparing them to heaps of cotton that should touch one another, and whose assemblage should form an undulated surface. As to the colour, the same thing happens precisely to water as to glass: it is well known that the most transparent glass becomes opaque, if after reducing it to powder you hold it up to the light; but appears with the whiteness of snow, if you look at it on the side that the light falls. It is the same thing when water is reduced into very little parcels or drops, such as are those in the clouds or in fogs. The little bubbles present too great a number of minute surfaces; they appear dark when looked at from *beneath*; whereas if the spectator is placed *above*, as we were often on the top of *Pichincha* and other mountains, all the rays being reflected and mixed, after having suffered divers refractions, form a
white,

white, agreeably to what we know of the properties of light.

One sees almost every day on the tops of these mountains an extraordinary phenomenon, which must be however as ancient as the world, and yet it doth not appear that any one hath taken notice of it before. The first time we observed it, we were altogether on the top of a mountain less high than Pichincha, and which is named Pamba-marca. A cloud in which we were involved *dissipating*, we saw the rising sun extremely splendid; the cloud passed on the other side, it was not thirty paces from us, and was at too small a distance to have acquired the *whiteness* I have mentioned; but every one of us saw his shadow projected on it, and each could see none but his own, because the cloud had an un-even surface. The little distance permitted us to distinguish all the parts of the shadow, we could discern the arms, the legs, the head; but what surprized us is, that the head was adorned with a glory, like what you see round the heads of saints in pictures, it was composed of three or four concentric crowns of a very lively colour, and each with the same varieties as a primary rain-bow, the *red* being outward. The intervals between these circles were equal, but the last circle was fainter; and at a great distance we saw a large white circle that invironed the whole. It was a kind of apo-

apotheosis to each spectator; and I cannot forbear mentioning again, that each one enjoyed the secret pleasure of seeing himself adorned with all these crowns, without perceiving *those* of his neighbours. I must observe however, that this phenomenon doth not appear unless the aqueous particles of the cloud are *frozen*, and therefore is not seen on drops of rain, as the rain-bow. It is probable that it might be perceived sometimes upon some of our lofty towers.

Several of the mountains in Peru are subject to eruptions of fire, and have been formerly vulcanos. Whilst Mr. De la Condamine and I were on one of the summits of Pichincha, which had been formerly a vulcano, it happened that another vulcano burst out in the eastern chain of mountains, and almost beneath our eyes; the melting of snows, the torrents of waters, the horror and consternation we were in must be left to the reader's imagination.

There is in all this range of mountains as far as I have travelled a constant *inferior* boundary beyond which the snow never melts; this boundary in the midst of the torrid zone (for it is less high in proportion to the distance from the equator) I found to be 2434 fathom above the level of the south sea. The snow indeed falls much lower, but then it is subject to be melted the very same day; whereas

whereas above *that* it preserves itself,

"The gather'd winter of a thousand years."

There must likewise be a *superior* boundary, beyond which the snow never falls at all; but it is probable that the highest mountains never reach it. If there were *any* sufficiently high to exalt their tops above all clouds, there would be that serenity, which Homer and Lucretius have vainly ascribed to Olympus,

Sedesque quietæ;

Quas neque concutiunt venti, neque nubila nimbis.

*Aspergunt, neque nix acri concreta pruina
Cana cadens violat; semperque innubilis
æther*

Integit, et largé diffuso lumine ridet.

Mr. De la Condamine and I went up once above the constant inferior boundary of snow upon a mountain called Chouffalong. Its rocky part hath the shape of a roof of a house, and its extremity towards the north being at that time almost intirely destitute of snow we took the advantage of it, altho' with a great deal of difficulty; when we were arrived at the top, we were surrounded by ice.

This mountain is 2476 fathom high, the mercury in the barometer stood at 15 inches 9 lines, which was a little more than 12 inches 3 lines *lower* than on the sea-shore. A barometer had never been carried to so high

a place, and it is probable that no one had ever mounted so high before; for a man must have some motive for undertaking such journeys. The desire of riches that actuates mankind, instead of leading them to the tops of such lofty mountains, rather induces them to dig into the bowels of the earth, where nature hath hid the shining mischief.

The mountains in the neighbourhood of Quito appear to contain but few metalline parts; altho' they have found there in times past, and still continue to find, some gold sand.

You cannot discern *here* any footsteps of great inundations, which have left such visible marks in every other region. It is very easy at Peru to observe the internal structure of the earth to a very great depth, because it is every where cut by deep trenches. These trenches are frequently 200 fathom broad and between 60 and 80 deep, there are some above double that size.

N. B. *This justifies the account Mr. Lemery hath given of the manner in which air is admitted into the bowels of the earth for the production of earthquakes, agreeably to his solution. Vid. pag. 15.*

By going down these caverns you may see all the qualities of the different *strata* of earth, but will discover no fossil. One finds there a great deal of that black sand, which is at-

tracted by the loadstone; and you may discern in general that the *strata*, whose colourings are very distinct, far from being the effect of different inundations of water, are rather the effusions of matter vomited by vulcanos: almost all appears to be the work of fire. Some of these mountains even to a very great depth consist of nothing but scoria, pumice stones, and fragments of burnt stones of all sizes; and sometimes the whole is covered by a bed of common earth, which bears grass, and even trees.

Marks of ancient eruptions are visible in many places, but particularly at the foot of Cotopaxi. I fancy we saw the remains of that terrible eruption which all historians take notice of, that happened after the death of Atahualpa the last emperor, in the beginning of the year 1533. We could not without amazement behold the extraordinary marks of it, such as stones 8 or 9 feet long and as many thick, that had been thrown more than three leagues distant, and several of them forming *trains*, which indicated the vulcano from whence they had been darted. The Indians considered this eruption as a destiny foretold them, and as the fatal moment, wherein it was in vain to defend themselves against the invaders, that were appointed to subdue them.

The last fiery eruption of this mountain in the year 1742 happened in our sight, as I have mentioned before; but it caused no
other

other mischief than what followed from the sudden melting of the snow, the water rose in some places more than an hundred and twenty feet, its impetuosity carried off an infinite number of cattle; swept away five or six hundred houses, and drowned eight or nine hundred persons. All this water had 17 or 18 leagues to run, or rather to ravage in the Cordilleras towards the south, before it could have any issue from thence at the foot of Tonguraga; it was no more than three hours in traversing that extent of ground. This eruption opened a new vent on the side, about the middle of the height of the mountain.

As the torrid zone and the frozen zones are so blended, as I may say, at Peru, that one finds *there* the most contrary climates, that it is sufficient to go a few leagues, to enter into the Cordilleras or to go out of them, in order to find countries more different one from another than you will find in travelling over all Europe; this extreme difference cannot fail to occasion a diversity in the customs and even in the tempers and dispositions of these people. At the bottom they live retired in their forests, forming as it were little republics under the direction of their pastor, who is a Spaniard, and their governor, assisted by some other Indians that serve him as officers. They live in as great harmony as they appear to live in perfect innocence: they

X 2

are

are courteous and honest, incapable of any mistrust, and it never comes into their thoughts that any one can have an intention to deceive them. The doors of their houses are always open, altho' they have cotton, gourds, little pieces of money, a kind of aloes from which they get thread, and some other commodities of which they often make traffick. The great heat permits them to go almost naked; they paint their bodies commonly red; instead of painting them intirely throughout, they make only streaks, and draw them even on their faces. This custom seems to have taken rise from precaution against the bite of a kind of gnats, the multitude of which is extremely great in all the lower parts of the torrid zone, where the land hath not been well cultivated.

These same Indians are *of all* trades that are necessary to them; they are carpenters, architects, ship-wrights for building small vessels, and weavers. As to any great works, such as building houses, the custom is for an Indian to invite all those of his neighbourhood, who work in common, and have no other pay than elegant entertainment. The house, however large it may be (for in some places three or four separate families lodge under the same roof) by such a number of hands is finished in one day, and sometimes requires no more than an hour's labour.

They

They have the advantage of joining to the fruits of the earth, which are in vast abundance, a great plenty of provisions by shooting and fishing. They kill their game either with arrows, which are sometimes the poisoned arrows, or with balls of clay shot from a kind of pop-guns; as to fishing, it is by so much the more easy, as the rivers, having no longer that declivity which made them such furious torrents in the mountains, contain fish in abundance *here* below.

I have had the opportunity of observing that those, who live immediately at the foot of the Cordilleras on the western side or towards the south sea, are almost as *white* as we. These are not exposed like the others to a violent and continual drying wind; on the contrary, they pass their days in a country, where there reigns such a perfect calm, that it is never interrupted by the least blast of wind, the mountain sheltering them from the continual easterly wind, which must pass near a league over their heads. If you go further from the Cordilleras towards the coast, the wind hath a great effect upon the skin, and the Indians have their usual colour, of copper. It is true that if the flesh colour of the *former* doth not differ from ours, yet *they* are sufficiently distinguished from *us* by having no beard, nor hair upon their breasts, nor in any other part of the body; and what characterizes them still more is their long head

of hair; they have always big, black, lank, and very strong hairs.

The condition of the Indians that live aloft in the Cordilleras is not the same, but they are intirely a different sort of men. They have as many *bad* qualities as the others have *good*. They are all extremely idle and stupid; they will pass whole days in the same place without stirring, or saying a word.

It must be owned that when one compares the Indians both without and within the Cordilleras with the *paintings* that some historians have given of them, one can scarce believe one's own eyes; all that *they* have related of their talents, of the different constitutions of government, of their laws, and policy, appears a mere dream, and would be suspected if there did not remain several monuments, which prove invincibly that we must not judge of the ancient state of these people by what we see at present.

One cannot conceive how they could raise the walls of the temple of the sun, the remains of which are still seen at Cusco; these walls are formed of stones 15 or 16 feet in diameter, and which, tho' rough and irregular, do all so exactly fit one the other that they leave no *void* between them. We saw the ruins of several of those edifices, which they called *tambos*, and made use of as magazines; *there* the Incas lodged when they travelled. The gates of the *tambos* are not wide
but

but extremely lofty, because the sovereign never went out but he was carried in a kind of litter, supported on the shoulders of the principal lords of his court. The walls are often of a sort of granate. All these edifices were situated along the magnificent road that led into the Cordilleras from Cusco to Quito, and was near 400 leagues long; we could often trace the remaining footsteps of this road. I shall not describe the different intrenchments made with art upon the summit of several mountains, which must be attributed to the natives of the country when they dearly sold their liberty to the other Indians, that came from Cusco under the conduct of Huayna Capac, before he was yet emperor, and a little before the entrance of the Spaniards. It is probable that the tombs of a surprising grandeur and form, which we found in a place named Cochesqui, were raised about the same time. They are mounds of earth, some of which have 40 feet in height upon 420 in length and 240 in breadth, with flights of steps extremely long that lead to the top by a very easy ascent. There are seven or eight of *this* form, and more than an hundred of a different *one*.

Historians make mention of a palace that the Incas had in the same place, but no mark of it remains; whereas the tombs, which no historian hath mentioned, are still subsisting.

Almost all the ancient works of the Peruvians have been subject to the same fate,

— *Ipsæ periêre ruinæ.*

The more they have attracted attention, the more they have been destroyed.

All that I can add is, that it is impossible to behold such monuments as are still remaining without being disposed to think advantageously of those, who had the boldness to undertake and the resolution to finish them.

Memoirs 1744, pag. 252.

It is needless perhaps to remark to the reader, but I take a pleasure in repeating it, that all the observations at Peru, as well as at the polar circle, confirmed the Newtonian theory.

Natural
curiosities
observed
in the
course of
the river
of the
Amazons,
by Mr. de
la Conda-
mine.

In order to multiply opportunities of making remarks in that part of the world whither we had been sent to determine the figure of the earth, we agreed, Mr. Godin, Mr. Bouguer, and I, to return back by different roads. If curiosity alone had determined my choice, I should not have hesitated to take the road of Mexico or of Paragua; but I preferred another, which was much more unknown, and that I was sure no one would envy me; it was *that* of the river of the Amazons, which passes for the greatest river of the world, and which crosses the whole continent of south America, from west to east. I knew that this enterprise had its difficulties; but after having maturely reflected on them, I judged that

that none of the obstacles, which had been alledged in order to divert me from my project, were unsurmountable with a little resolution. The less travellers have had opportunities of penetrating into those vast regions unknown to the rest of the world, the more I hoped to render my voyage useful, by taking a map of the course of the river as I went down it, and by collecting observations in every kind, which I should have the opportunity of making in a country so little frequented.

I must observe that the extremely faulty map of the course of the river of the Amazons, made by Sanson from relations merely historical, hath been copied by all geographers *since*, for want of new memorials; and we never had a *better* till the year 1717 in the 12th tome of *Lettres edif. et cur.* copied from a draught of father Samuel Fritz a German jesuit, missionary for the crown of Spain on the borders of this river: but he had not conveniencies for giving an exact map; and therefore I have given another, in which I have marked the course of the river according to father Fritz, that the reader may discern the difference between us. I am sensible however that my own is very far from perfection, which in drawing the course of a river is very difficult to be attained, especially on so narrow a scale.

It is commonly thought that the first European who discovered this river, which went
by

by the name *Maragnon*, was Francis d'Orellana in the year 1540. The report he made of having met with some armed women in going down the river, of whom an Indian captain bad him beware, occasioned the name of *river of the Amazons* to be given it in the patent granted in Spain to Orellana for the conquest of this country.

The Maragnon or river of the Amazons, after issuing from the lake *Lauri-cocha*, where it takes its rise at about 11 degrees of south latitude, runs northward as far as Jaen at 6 degrees of south latitude; from thence it takes its course eastward, almost parallel to the equinoctical line quite to Cape de Nord, where it enters into the ocean just beneath the equator itself, after having run from Jaen, where it begins to be navigable, 30 degrees in longitude or 750 common leagues, which, *allowing* for the windings of its course, must be reckoned 1000 or 1100 leagues, *that is* 3000 English miles. It receives on its north and south side a prodigious number of rivers; several of which have a course of five or six hundred leagues, and some of them are not inferior to the Danube and the Nile. The borders of the Maragnon were peopled about a century ago by a great number of nations, which have retired further within land in order to avoid the Europeans. One finds *there* at present only a few little towns, consisting of the natives of the country, that have been lately

lately drawn out of their woods, either *they* or their fathers, by Spanish missionaries on the upper part of the river, or by Portuguese missionaries who are settled in the lower part.

I set out from Tarqui, which lies five leagues to the south of Cuenca, on the 11th of May 1743. In my journey to Lima in 1737, I had taken the usual road from Cuenca to Loxa: this time I turned out of that road to go to Saruma, in order to fix that place upon my map. I ran some risk in fording the great river *de los Jubones*, which was very much swollen at that time, and is always extremely rapid; but by this danger I escaped *another* much greater, of being assassinated, for people had been hired to way-lay me on the other road, to prevent my carrying complaints to the council in Spain against the iniquity of a sentence of the *royal audience* at Quito.

From a mountain, over which I passed in my road from Cuenca to Saruma, you see Tumbez, a port of the South-sea, where the Spaniards first landed on the other side the line, when they conquered Peru.

I found the height of the mercury in the barometer at Saruma 24 inches 2 lines; it is well known that the barometer doth not vary in the torrid zone as in our climates; I am perfectly assured from observations made at Quito during the compass of whole years, that its greatest difference scarce ever exceeds

a line and half. Mr. Godin was the first who observed that these variations, which are about a line in 24 hours, have pretty regular stated periods at the same hours of the day.

I found by frequent experience on the coasts of the South-sea, that the mercury at a medium, on a level with the sea, was near upon 28 inches; from whence I may conclude, agreeably to Mr. Bouguer's table,* founded on an hypothesis that corresponds the best with all our observations of the barometer, taken at divers elevations which were determined geometrically, that Saruma is situated about 700 fathom high, which is not half the height of the ground on which Quito stands.

In my road I met with several rivers that I was obliged to cross upon bridges of cords made of the rinds of trees, or of a sort of osiers. These osiers, twined in the manner of net-work, form from one shore to the other a gallery suspended in the air by two great cables made of the same materials, the extremities of which on each side are fastened to branches of trees. The whole presents the same sight as a fishing-net or an Indian *bamac*, stretched from one side of the river to the other. As the meshes of this net-work are very large, and the foot would be in danger of slipping through, they take care to strew some reeds at the bottom, which
serve

* Vid. essai d'optique sur la gradation de la lumière, p. 153.

serve for a floor. The reader will easily conceive that the mere weight of this kind of basket machine, and much more the weight of a man passing over, must cause it to make a prodigious bending; and if it be considered that the passenger, when he is in the midst of his course, especially if there be a wind, is exposed to vast swingings from side to side, I need not mention that a bridge of this sort, sometimes more than 90 feet long, must at first sight be extremely frightful: yet the Indians, who are far from being naturally courageous, pass over it *running*, though loaded with all the baggage and pack-saddles of the mules, that they make swim across the river, and laughed to see us hesitate in venturing. But *this* is not the most singular nor the most dangerous sort of bridge that is made use of in this country.

I was obliged to tarry some days at Loxa, which is situated 4 degrees beyond the equinoctial line, about an hundred leagues to the south of Quito, and one degree more westerly. The barometer stood *there* at 22 inches 1 line, from whence I conclude that Loxa is about 1100 fathom above the level of the sea, and 400 fathom lower than Quito; a difference that produces a very sensible alteration in the climate. At Quito the air is always temperate, at Loxa the heat is sometimes troublesome: from Cuenca, the ground continually sinking, you lose out of sight,

fight, by little and little, those dry uninhabitable summits that you see so frequently in the Cordilleras; and the mountains in the neighbourhood of Loxa, covered with woods and verdure, are no more than hills in comparison of those about Quito.

The third of June I spent the whole day on one of these mountains: with the assistance of two Indians of the neighbourhood that I had taken for my guide, I could not in the whole day collect more than eight or nine young plants of *Quinquina* (the bark) that were fit to be transported. I had them put with earth taken from the spot in a box of a sufficient size, and carried on the shoulders of an Indian that walked in my fight, I used the same precaution quite to the place where I embarked. I flattered myself that with all this care and attention I should preserve at least one plant, and proposed to leave it in trust at Cayenne, if it was not in condition to be transported immediately into France to the royal garden.

From Loxa, or rather from Caxanuma to Jaen, you go down the vale, where Chinchipé runs, and keep along at some distance from the river, which in its short passage receives several other considerable streams. In the road I went, leaving the river to my right, I crossed five or six of them that run into it on the eastern side; some I forded, others I passed on osier bridges, or on floats
which

which are made *on the spot* of a very light timber, that nature hath amply provided this whole country with.

It is impossible to convey a complete idea of the difficulties in this journey, and of the inconveniences to which one is exposed. These rivers that run across your road, are separated from each other by eminences which would be called mountains every where else: so that you must continually be going up or down, sometimes by a kind of ladder-steps cut naturally in the rock, and creep up side-long the hollows which the torrents have made: afterwards you must descend by a path with a steep declivity, upon a slippery soil, where the mules are obliged to squat on their buttocks, and holding their fore legs stiff to slide down the precipice. At other times you have not precipices bordering the rivers, but are obliged to make your way through thick woods, where you can scarce see day-light: you can find no other road than a miry path-way, where your mules sink every step above their knees. In this slow and dangerous way of travelling there is another circumstance enough to put you out of all patience, which is that it rains in this district five or six hours at least every day for ten or eleven months, and sometimes the whole year. I travelled *thus* fifteen days, eight or ten hours each day, and got no further than forty leagues.

I spent some days at Jaen, where I observed 5 degrees 25 minutes of south latitude and I judged it about half a degree to the east of Loxa. I set out from Jaen the 23^d of June; I kept along the north side of the Maragnon or river of the Amazons for two days, and judge that I did not travel more ground than six leagues: the beasts on which we were mounted and the sumpter cattle could only march step by step on the side of a steep hill, often in a narrow and slippery path, from whence the sight of the river and the depth to its channel make your head swim, whilst your ears are stunned with its noise.

In this journey I crossed several torrents that without doubt wash very rich mines of gold, since they roll and deposit on the borders a sand mixed with grains and particles of that metal. After the great rains a man may collect a dram or two of it in a day: yet the neighbouring Indians do not go out to look for it, till they are constrained to pay their tax or capitation; and even then they do not load themselves with more than the quantity which is necessary to satisfy the demand. The surpluseage would only be a troublesome weight, and they would sooner trample under foot all the gold in the world than give themselves the pains of picking it up and separating it.

In all this district, the two sides of the river are covered with *wild* cocoa nuts, that are not inferior to the *cultivated*. The example of the Spaniards hath not taught these Indians to make use of them, and the badness of the roads preventing all exportation, hinders any useful commerce being made of these fruits.

The next day in the evening after my departure from Jaen, I crossed the Maragnon on a float, and lay on the opposite shore. The third day in the morning, in order to ease my mules, I made use of the same float to go down the river to the place where the road that leads to the *embarcadero* (or place of embarking) runs wide of the river. The fourth day of my departure from Jaen, and the last of my journey by land, I was transported with the thoughts of taking a farewell for ever of mules, mule-drivers, and roads of Peru, which had exercised my patience for eight years ; but there yet remained to pass two and twenty times a torrent that throws itself into the little river of Chuchunga, where I was going to embark ; these torrents were made by the last steps of the Cordilleras, that remained for me to descend ; as the waters were high, the fords were become deeper than usual at each *passage*. At the *sixth* I had water quite up to the pommel of my saddle, and in all the *succeeding* my mule swam ; at one of *them*, one of my

mules was carried away by the violence of the torrent, with his burden; two Indians threw themselves into the water, and swimming excellently well recovered it: a canow, that the *cacique* of Chuchunga sent to meet me, luckily saved me the two or three last passages, which were the most difficult; but the mules impatient to get to their accustomed resting place, threw themselves *in*, loaded as they were, and swam across: my instruments, my books, my journals, my papers, my maps, and designs were all wetted; which was the fourth accident of that kind which had happened to me since I had travelled in the mountains. It may truly be said, that my shipwrecks did not cease 'till I got on shipboard.

I found at Chuchunga an hamlet of ten Indian families, governed by their *cacique*: the Indians at Chuchunga had only very small *canows*, which are the most proper for their use; and *that* which I had sent to get at Sant-Jago by an express, could not arrive under a fortnight; I prevailed on the *cacique* to get me a float made by his people; the time necessary for preparing the *balse* (for *so* they call a float, as well as the timber of which it is made) gave me an opportunity of drying my papers, and my books leaf by leaf, a precaution as necessary as it was tiresome: the sun did not shine out 'till about noon, which was sufficient to take its meridian altitude.

titude. I found myself at 5 degrees, 21 minutes of south latitude, and I learnt from the barometer, which was between 15 and 16 lines lower than on the sea-shore, that there are at between 220 and 230 fathoms above the level of the sea, rivers navigable in a continued and uninterrupted course; for I never travelled by land after my departure from Chuchunga. Perhaps *this* is not the only river, of which it may be said, experience alone can decide that point; it is certain the opportunity cannot often present itself of making the observation on a river of such an elevation, and at three thousand miles distance from its mouth.

I had *now* been eight days in the hamlet of Chuchunga, and they had swiftly passed away; I had neither robbers nor inquisitive persons to fear; I was indeed in the midst of *savages*, but *that* only gave a relish to this kind of life by its contrast to the busy, bustling, envious crouds of *men*; after several years past in continual motion and agitation, I now enjoyed for the *first time* a sweet tranquillity: the remembrance of my fatigues and dangers appeared to me as a dream; the silence that hovered over this solitude made it the more pleasing to me, and I seemed to breathe a purer air; the heat of the climate was tempered by the coolness of waters that had just issued from their spring, and by the thickness of woods that over-hung the

Y 2 streams;

streams; a prodigious number of uncommon plants and flowers unknown attracted my sight, and continually amused with their novelty and variety. In the intervals of my labour in drying my cloaths and papers, I partook of the innocent pleasures of the Indians; I bathed with them, and was charmed with their dexterity in shooting and fishing; they always brought me the choicest of their fish and game; I was treated like a prince by the cacique himself; the most delicious perfumes gave me *light*, as Circe is described in Virgil,

Urit odoratam nocturna in lumina cedrum,

and I trod on sands of gold.—Word was brought that the float was ready, and, as if I had been touched by Circe's wand, the visionary scene was fled.

On the 4th of July in the afternoon I embarked on board a little canow of two oars, preceded by the float loaded with my equipage, and escorted by all the Indians of the hamlet; they were in water up to their middles, in order to conduct my vessel with their hands in dangerous passes, and to hold it back amidst rocks, and in little falls of water, against the violence of the current. The next day in the morning, after many windings, I entered into a little river called *Imaça*, and from thence opened into the Maragnon or river of the Amazons, at about 4 leagues northward

northward from the place where I had embarked; it is *there*, properly speaking, that the true bed of that river begins to be navigable, without any *fall* disturbing its course. It was necessary to enlarge and strengthen the float, which had been proportioned to the bed of the little river I had descended. We stopped for this purpose on a flat shore of sand called *Chapuruoma*; in the night the river increased ten feet, and it was necessary to convey on board the float, with the utmost expedition, a kind of harbour that served me for a shelter: the Indians build these sorts of lodging with admirable art and quickness. I was detained in this place three days, and employed them in measuring geometrically the breadth of the river, which I found to be 810 feet, although diminished about 100 feet; several rivers that it receives above Jaen are broader, which made me imagine that it must be of a great depth; with a line of 28 fathom I could not sound its depth above a third of its breadth; in the midst of the channel, where the swiftness of a canow abandoned to the current was at the rate of seven feet and an half in a *second*, I could not make any sounding. The barometer, higher than at the port by about 5 lines, shewed me that the level of the water was sunk about 70 fathom from Chuchunga, in which passage I had employed no more than eight hours; I observed

at the same time the latitude to be 5 degrees 1 minute south.

On the 12th of July I passed the famous canal of Pongo ; it begins a small half league below St. Yago, and from 1500 feet *at least* just below the union of the two rivers, it contracts itself to 150 feet in its narrowest part. I observed by my watch 57 minutes from the entrance of the streight to my arrival at Borja, though it is commonly said that the passage is performed from St. Yago to Borja in a quarter of an hour ; they reckon it likewise *three* leagues, but I found it to be scarcely *two*.

There is in the middle of the Pongo, and in the narrowest part of it, a rock extremely high when the waters are low ; but it was more than a fathom under water when I passed ; it caused however an extraordinary eddy in the water, which whirled *about* my float: In the *turnings* the float struck two or three times against the rocks, and would have frightened me, had I not been warned of it before. A canow (which can never pass *here* but when the waters are low) would have been split into a thousand shivers ; but the pieces of a float not being nailed or joined, the flexibility of the osiers, that tie them together, hath the effect of a spring that deadens the blow ; the steepness of the rocks on each side, which seem almost to join at the top, and the trees, that jutt out and form a
kind

kind of arch *above*, throw such a gloom over the whole canal, as strikes one with its singular and pleasing appearance; I had scarce time enough to enjoy this scene, before the view of Borja opened to my sight; and as soon as I arrived thither, I thought myself in a new world, separated from all commerce with mankind, on a sea of fresh water, in the midst of a labyrinth of lakes, rivers, and canals, diffusing themselves through an immense forest, which they alone render accessible. I saw new plants, new animals, new men; my sight that had been tired for seven years with gazing up^d to mountains, was now refreshed with ranging through the wide expanse of heaven, where nothing bounded the view on any side but the hills and woods above Pongo; the eye delighted to skim along the surface of the water, or dwelt with pleasure on the level verdure of the forest.

Below Borja, and for 4 or 500 leagues down in the course of the river, a flint stone is as great a rarity as a diamond. The savages of those countries know not what a *stone* is, have not so much as an idea of it. It is a very diverting sight to see some of them, when they come to Borja, and meet with some stones for the first time, shew their admiration by signs, eagerly picking them up, and loading themselves with them, as *precious* commodities.

Although there is great diversity in the various nations that inhabit this vast tract of country, with respect to their complexion (which probably is owing to the different temperatures of climates) with respect to customs, manners, &c. arising chiefly from mixtures of Portuguese and Spanish; yet the general fund of character is through all the same; and I am sorry to say that it is stupidity, or at the best a puerility, which makes their fundamental character; they are either sensual or childish, voracious gluttons, and sober only through necessity, cowards to an excess, unless inspirited by liquor; indolent, and insensible of any motive of glory, honour, or gratitude; they express their joy by jumping and immoderate laughing, and grow old without ever quitting childhood; one cannot without a mortifying sentiment perceive in *them*, how little *human* nature, destitute of education and society, differs from the *brute*.

All the languages of South-America, as far as I have been able to get any knowledge of them, are very *scanty*; yet several of them have an energy, and are susceptible of elegance, in particular the ancient language of Peru; but all of them want terms to express abstract, and general ideas; which is an evident proof of the little improvement of the *understanding* amongst them: *time, duration, space, being, substance, matter, body, and ma-*

ny other such words, have nothing equivalent in their languages; not only names of a metaphysical, but likewise *those* of a moral nature cannot be rendered in their tongue but imperfectly, and by a circumlocution; they have no words that correspond exactly to those of *virtue, justice, liberty, gratitude, and ingratitude*. What I have said will appear inconsistent with what Garcilasso reports of the policy, industry, arts, government, and genius of the ancient Peruvians; if the love of his country did not delude him, it must be acknowledged that these people have greatly degenerated from their ancestors. It is said that some caciques of the upper Peru deserve to be excepted from the judgment I have given in general of these Indians; but I appeal to *those* who have had the opportunity to frequent them.

I have made a vocabulary of the words that are most in use in the divers languages of America; the comparison of these words with those which have the same signification in other languages of the inland country, may not only serve to prove the divers transmigrations of these people from one extremity to another of this vast continent; but likewise the comparing them, where it is possible, with the various languages of Africa, Europe, and the East-Indies, is, perhaps, the only means of discovering the origin of the Americans: a conformity of language
well

well averred would without doubt decide the question; the word *abba*, *baba*, or *papa*, and that of *mama*, which from the || antient eastern languages seem to have passed with very little alterations into the greatest part of the languages of Europe, are common to a great number of nations in America, whose language is in other respects extremely different. If *these* words are considered as the first sounds that children are able to articulate, and consequently as those which must naturally be adopted by parents in every country to make them serve for signs of the ideas of *father* and *mother*; yet still the question will remain, how comes it to pass that in all the languages of America, where these words are to be found, their signification hath been preserved without varying; by what chance in the Omague language, for example, in the center of the continent, hath it never happened that *papa* should signify mother, and *mama* father, but that their signification *there* hath been constantly fixed, as in the languages of the East and of Europe?

As to the question Mr. De la Condamine hath proposed, I think the true solution of it is this; the vowel a is the most easy of pronunciation, and you may observe infants mimick the sound long before they are able to articulate; by degrees they join some consonant to it; now the letter m is the least difficult of all, in short,
it

|| Vid. Homer, Iliad vth, verse 408.

it requires only a gentle striking of the two lips, with a free passage of air through the nose; as ma-ma therefore will be the most easy, and by consequence the soonest pronounced, it will naturally in all languages be applied to the mother, with whom the child is first acquainted.

I observed at Borja the latitude to be 4 degrees 28 minutes south, and the variation of the compass near 9 degrees towards the north-east.

I set out from thence the 14th of July with father Magnim, who was willing to accompany me as far as Laguna; we left the 15th to the north of us the mouth of the Morona, which descends from the Vulcano of Sangay, whose ashes fly sometimes across the provinces of Macas and Riobamba beyond Guayaquil.

The 19th we arrived at Laguna, and I observed the latitude to be 5 degrees 14 minutes.

I set out with two canows from Laguna the 23d, accompanied by Mr. Maldonado. On the 25th, we stopped at a new religious establishment of Savages called *Yameos*, that have been very lately drawn out of the woods; their language is of an inexpressible difficulty, and their manner of pronouncing it is still more extraordinary than the language; they speak without sounding almost any vowel; they have words which we cannot write even imperfectly without employing nine or
ten

ten syllables, and yet these words pronounced by them seem to have no more than three or four; *poetarrarorincouroac* signifies in their tongue the number *three*; it is happy for those who have any business with them, that their arithmetic doth not go any farther; however incredible it may appear, this is not the only Indian nation that is in this condition; the Brazilian language, which is spoken by a people less savage, is under the same want; when they have passed the number *three*, they have nothing but a vague term which means a multitude, and, in order to count *four*, are obliged to borrow the aid of the Portuguese language.

The Yameos are very skilful in making long *sarbacanes* (pop-guns) which is the usual instrument of the Indians for killing game; they adjust to it little arrows that are made of the palm-tree wood, and, instead of a feather, are fledged with a little roll of cotton, which exactly fills the hollow of the tube; they dart the arrow with their breath to 30 or 40 paces, and scarce ever fail to hit the mark.

I have often seen a canow stop, an Indian land, go into the wood, bring down a monkey or a bird perched on the top of a tree, carry it away, take up his oar again, and *all* performed in less than two minutes. An instrument as simple as these *sarbacanes* supplies amongst all these nations the want of fire-arms;

arms; they dip the point of these little arrows, as well as *those* for their bows, in so active a poison, that when it is fresh it kills an animal in less than a minute, if it but touches the blood. Although we had fowling-pieces we seldom fed on any game but what was killed by these arrows, and often found the point of the arrow under our teeth; but the venom occasions no mischief when taken by the mouth, as Lucan hath observed with respect to the poisons of Africa,

*Ne dubita, miles, tutos haurire liquores :
Noxia serpentum est admisto sanguine pestis :
Morsu virus habent, et fatum dente minantur :*

Pocula morte carent.—

We saw at Parà several Portuguese that had seen the fatal effects of these arrows on their comrades, *in an instant*, and from a wound no bigger than the prick of a pin; salt, but more certainly sugar, is commonly thought to be an antidote to this poison.

During my continuance at Cayenne, I had the curiosity to try if the venom of the poisoned arrows, which I had kept more than a year, had still preserved its activity, and at the same time whether sugar was in reality a counterpoison so efficacious as I had been assured.

A fowl slightly wounded by blowing from a sarbacane a little arrow, whose point had
been

been smeared above a year before with the venom, lived no longer than 7 minutes and half; another wounded in the pinion with one of these same arrows, but which had been freshly dipped in the venom diluted with water, and was immediately drawn out again from the wound, appeared drowsy in a minute *after*; convulsions soon followed, and although we made it swallow sugar, the fowl expired; a third, pricked in the same place with the same arrow fresh dipped in the poison, having had the same remedy immediately applied, gave no sign of any disorder.

I repeated the same experiments at Leyden, in the presence of Mess. Muffenbroek, Albinus, and Vanswieten, the 23d of January 1745; the poison, whose violence must have been very much weakened by the length of time, and the cold weather, had not its effect under five or six minutes; but the sugar was given without success; only the fowl that took it appeared to live a little longer than the other; the experiment was not repeated.

This poison is an extract made by distillation from the juices of several sorts of plants, and particularly certain creepers (called *lianes*;) they say that there are more than thirty sorts of herbs or roots which enter into the composition of the poison made by the *Ticunas*; it was *this* I made my experiments with, and it is the most in esteem of all the sorts

known along the river of the Amazons. The Indians compose it always in the same manner, and follow the process they have received from their ancestors as scrupulously as our pharmacopæias proceed in the solemn composition of the *theriaca*; tho' probably that great multiplicity of ingredients is no more necessary in the Indian poison, than in the European *antidote*.

The reader undoubtedly will be surprized at what I am going to mention, that amongst these people, who have at their disposal so certain and so speedy a means of satisfying their hatred, jealousy, and revenge, so subtle a poison should be fatal only to monkeys, apes, and birds: especially when it is considered that these people, so harmless, are at the same time savages, and most commonly destitute of any notion of religion.

I cannot forbear observing that the most savage and the most stupid people have been the most ingenious in the arts of poisoning, and have contrived such methods of giving a speedy or at other times a slow but certain death, as have greatly puzzled the philosophers of civilised countries to discover. But the reason seems to be this, If it be an animal poison made use of (as Pliny reports of the Scythians that they poisoned their arrows with the sanies of vipers) that the animals are less vigorous with their poisons in the colder and more civilised countries; or if the poison be derived from plants,
that

that those plants are either not found in these countries, or greatly degenerate by the soil and climate. I beg leave to produce an instance, which will at the same time give light and authority to a passage in the Cyri Expedit. Lib. iv.

*Xenophon mentions in the famous retreat of the ten thousand “ that the soldiers sucked
 “ some honey-combs in a place near Trebi-
 “ zonde where there was a great number of
 “ bee-hives, that all who sucked them be-
 “ came intoxicated, vomited, and purged;
 “ not one was able to stand upon his legs,
 “ those, who had taken but little, were like
 “ men drunk, but those, who had taken a
 “ good deal, were like men mad, and some
 “ lay like men dead: the next day about the
 “ same hour they recovered their senses, but
 “ it was three or four days before they were
 “ entirely restored, as if they had taken a
 “ poison.” This fact cannot be a romance
 from so grave a writer, who was present and
 for a considerable time had the principal com-
 mand. Mr. Tournefort in his travels through
 this country was particularly attentive to this
 account of Xenophon, and observes that the
 chamærhododendros pontica, maxima, mes-
 pili folio, flore luteo, which grows commonly
 in the neighbourhood of Trebizonde, hath these
 effects, and that even its smell affects the head;
 he judges therefore that the honey had been ex-
 tracted by the bees from the chamærhododendros,
 and*

and adds, that father Lamberti a missionary observes that the honey which bees gather from a certain shrub of Colchis or Mingrelia is dangerous, and causes vomiting; from the description Mr. Lamberti hath given of the shrub, Mr. Tournefort pronounces it to be the *chamaerhododendros, mespili folio*; its smell very much resembles the honey-suckle's, but is much stronger. *Vid. memoirs 1704, pag. 351.*

It is but within a few centuries that the *lauro-cerasus* was imported into Europe, from Trebizonde, and but within a few years that it hath been found to afford so sudden a poison; I know some other vegetable extracts that give as speedy a death, but as they are not commonly known, I shall not divulge them. But to return to my subject, as these plants grow only in the hot countries or at least degenerate frequently by being transplanted, it is no wonder that the inhabitants of those countries, altho' savages, should be the first discoverers of such poisons, and the most artful in applying them.

The next day, 26th, I sounded the river in a place free from any island, where its bed, that a little above was 4200 feet wide, had contracted itself to less than 900; I found no bottom at 80 fathom.

A little further on the south side of the river we met with the mouth of the *Ucayalé*, one of the greatest rivers that run into the Maragnon. Below the *Ucayalé* the breadth

of the Maragnon enlarges greatly, and the number of its islands increases.

The 27th in the morning we landed at the mission of St. Joachim, composed of several Indian nations, and particularly of the *Omaguas*, formerly a very powerful people. A nation that bears the same name *Omaguas*, and which dwells near the source of one of those rivers that rise in the new kingdom of Granada, and run into the Maragnon; the use of clothes which we found established amongst the *Omaguas* *alone* of all the nations that people the borders of the Amazon; some remains of the ceremony of baptism, and some disfigured traditions, are an evidence of the transmigration of this people. Father Samuel Fritz had converted them to the christian religion at the end of the last century, and there were reckoned *then* in their country thirty villages marked with their names on the map of that father. All the inhabitants of these villages, frightened by the incursions of some robbers, that came to get slaves amongst them, dispersed into the woods, or into the Spanish and Portuguese missions.

The name of *Omaguas* in the language of Peru, as well as that of *Cambevas*, which the Portuguese of Para give them in the language of Brazile, signifies *flat-head*. The reason of this name is, that these people have an odd custom of pressing between two boards

boards the upper part of the head of children as soon as they are born, and procuring them the strange figure that results from thence, in order to make them resemble, as they say, the full moon.

The Omaguas make great use of two sorts of plants, the one is called by the Spaniards *floripondio*, the flower of which hath the figure of a bell inverted; the other in the Omagua language is named *curupa*; they are both purgative. These people procure themselves by means of these plants a drunkenness, that lasts for 24 hours; during which they have very strange visions. They take likewise the *curupa* in powder as we take snuff, but with greater ceremonies: they make use of a reed terminated like a fork, or in the shape of the letter Y; a branch is inserted into each nostril: this operation followed by a violent inspiration, causes them to make wry faces that are very ridiculous in the eyes of an European, who cannot forbear referring every thing to his own customs.

The language of the Omaguas is as soft and easy to pronounce, and even to learn, as *that* of the Yameos is rough and difficult: it hath not the least conformity with the language of Peru nor of Brazil, the former of which is spoken *above* and the latter *below* the country of the Omaguas, along the course of the river.

The multitude and diversity of trees, shrubs, and plants on the borders of the river of the Amazons, and of the other rivers that empty themselves into it, are immensely great; and to many of them great virtues are attributed by the natives. This at least is certain, that from *bence* were obtained the bark, the ipecacuanha, sarsaparil, guajacum, &c. And one would think that such a treasure already found would incite the curious botanist, and the beneficent physician to make further enquiries in a country so fertile.

What strikes a stranger the most is the vast variety of creepers, some winding in serpentine folds round trees and shrubs, and, after having reached to a great height, striking back again to the ground take fresh root, and shoot themselves forth anew; others carried obliquely by the wind or some other accident spread themselves from tree to tree, and forming a confusion of cordage present to the sight the same appearance as the tackling of a ship.

The gums, the resins, the balsams, all the juices that flow by incision from divers sorts of trees, and the different oils that are extracted from them, are innumerable. The rosin, called *cahoutchou* in the countries of the province of Quito bordering on the sea, is likewise very common on the borders of the Maragnon, and serves for the same uses. When it is fresh, they give it by moulds what
form

form they please; it is impenetrable by rain, but what renders it more remarkable is its great elasticity. They make bottles of it, which have an advantage over glass in not being brittle, butts, and hollow bowls, which become flat by pressure, and as soon as they are free from constraint resume their former figure. The Portuguese of Para have taught the Omaguas to make with the same resin pumps or syringes, in the shape of a pear, which have no need of a piston, but squirt the water, they are filled with, by squeezing.

We changed our canows and their equipment at St. Joachim. Mr. Maldonado and I had come from Laguna in two canows, the one 42 the other 44 feet long, and each was only 3 feet wide and formed of a single trunk of a tree. We had 16 rowers divided between the two, who are placed from the head of the vessel to about the middle; the passenger and his equipage are at the stern, and sheltered from the rain under a canopy, made with great art by the Indians of the leaves of the palm tree interwoven.

Having changed our canows we departed from St. Joachim the 29th of July and arrived at the mouth of the Napo the 31st. I found the latitude to be 3 degrees 24 minutes south. The difference of meridians between Paris and the mouth of the Napo I observed, by the emersion of the first satellite of Jupiter that night, to be 4 hours $\frac{3}{4}$. I judged the

Z 3

total

total breadth of the river Maragnon to be 5400 feet below the island, for I could not measure more than one arm of it geometrically : the Napo appeared to be 3600 feet wide above the islands, that lie dispersed at its mouth.

After I had made my observations we immediately departed, and the next day in the morning the first of August landed, at 10 or 12 leagues distance from the mouth of the Napo, at *Pévas*, which is at present the *last* of the Spanish missions upon the borders of the Maragnon. Father Fritz had extended *them* more than 200 leagues lower, but the Portuguese in 1710 got possession of the greatest part of that country.

The name *Pévas*, which the town bears where we landed, is the name of an Indian nation that now makes a part of its inhabitants ; for there are collected thither Indians of divers nations and different languages ; the greatest part of the new inhabitants of *Pévas*, are not yet christians, they are savages but lately drawn out of the forests ; the work hitherto hath been to *humanize* them, which is no small labour, and justly compared to the taming of lions :

*Silvestres homines sacer interpretisque deorum
Cædibus et victu fædo deterruit Orpheus ;*

Dictus ob hoc lenire tigres, rabidosq; leones.

I shall not enlarge on the manners and customs of these nations, and of a great number

ber of others that I have seen, but as far as they have relation to physics and natural history; thus I shall not speak of their commerce nor industry; I shall give no description of their dances, instruments of music, festivals, different sorts of arms, utensils for fishing and shooting, their odd ornaments with bones of animals, and fish-bones put into their nostrils and lips; I shall barely mention their cheeks being made full of holes for stuffing in the feathers of birds of various colours, and shall dwell only on a fact that may employ the reflection of anatomists; which is the *monstrous extension* of the lobe of the inferior extremity of the ear in some of these various nations, without the thickness of the ear being sensibly diminished by it; we have been surpris'd to see what is commonly called the tip of the ear 4 or 5 inches long, and bored with a round hole an inch and half in diameter; but we were told that we saw nothing extraordinary in this kind. The hole being made with a fish bone, they insert into it at first a little cylinder of wood, to which they substitute *one* that is bigger in proportion as the hole enlarges, 'till at last the end of the ear hangs down upon their shoulder. Their finest dress consists in filling this hole with a large nosegay, or tuft of herbs and flowers, which serves them as a pendant.

The problem proposed by Mr. De la Condamine appears to me analogous to what we ob-

serve of the progress of nature in other instances of a slow and gradual increase; for example, the pregnant uterus, whilst it enlarges, doth not become thinner, but rather grows thicker by distension; and the reason seems to be the greater flux of humours derived to the part.

They reckon it six or seven days journey by land from Pevas, the last of the Spanish missions, to *San Paulo*, the first of the Portuguese, which we performed by water in three days and three nights; in this interval you find no habitation on the borders of the river; the bed of the river enlarges *there* so considerably that one of its arms *alone* is sometimes near a mile broad. As this great extent of water gives a vast power to the wind, real tempests rise and frequently drown canows; we had two storms in our passage from Pevas to San Paulo, but by the great experience of our Indians, and the frequent conveniency of putting into some creek or rivulet that empties itself into the river, and waiting 'till the storm was over, we escaped all danger.

One of the greatest perils in this navigation is the meeting with some trunk of a tree rooted up, run a-ground into the sand or mud, and concealed under water; which would put the canow in danger of over-turning or splitting; as it happened to us once in drawing to land, in order to cut some wood whose virtues were boasted of for the cure of
the

the dropfy; to avoid this inconvenience the canows keep at a distance from the shore. There is another accident much rarer, but always fatal, which you run the risk of by keeping too near the edges of the river; this is the sudden fall of some tree, either by decay, or because the earth that supported it hath been undermined by the waters.

We reached in five days and five nights navigation from San Paulo to *Coari*; in this interval the Amazon receives on the north side two great and famous rivers, the first is the *Iça*, that rises from the neighbourhood of *Pasto*, to the north-east of Quito: the second is the *Yupura*, which hath its sources towards *Mocoa*, still further north; this river is a true geographical wonder on account of the several singularities which are particular to it; it is the same as Mr. Delisle, in his map of America, in 1703, names *Caquetà*, and hath improperly suppressed in his edition of the same map in 1722; it is still called *Caquetà* in its upper parts, but *that* name is entirely unknown at its mouths, by which it empties itself into the Amazon; I say its *mouths*, for there are really seven or eight different *ones*, formed by as many arms that detach themselves successively from the principal canal, and so wide one from another, that there is near 80 leagues distance between the first mouth and the last; the Indians give them divers names, which hath occasioned
them

them to pass for different rivers: one of the most considerable of its branches is called by *them* Yupura, and to conform myself to the usage of the Portuguese, who have extended this name still higher up the river, I shall call by the name Yupura, not only the arm *so* named anciently by the Indians, but likewise the trunk from whence this branch, and all the succeeding arise; all the country through which they run is so low, that in the season when the river of the Amazon swells, the whole country is floated: the borders of the Yupura are inhabited in some places by a wild and fierce people, that destroy one another, and several of them still eat their prisoners.

In the course of our navigation we had enquired every where of the Indians of divers nations, whether they had any knowledge of those *warlike women*, whom Orellana pretended to have met with, and whether it was true that *they* lived remote from the commerce of men, admitting them only once in the year, as father d' Acuna relates; we were told by *all* that they had heard their fathers say *so*, and added a thousand particularities, too long to repeat, but all tending to confirm the report that there had been formerly a republic of women, that lived *alone* without the society of men, and that they had retired towards the north very far within land, along the *Black River*, or near one of *those* that de-

scend from the same country into the Maragnon.

I must own that if there ever were any Amazons, this country is the most likely to have excited in women the courage and resolution of withdrawing from the society of men, by whom they are accustomed to wars, and at the same time treated as slaves; however, I cannot think there are *any* subsisting at present, but that either they have been subdued, or else tired of their solitude, the daughters have at length lost the aversion of their mothers to *men*. Some of their customs, and particularly *that* of cutting off one of their breasts, are circumstances probably added by the Europeans prepossessed with the customs that have been attributed to the ancient Amazons of Asia,

*Ducit Amazonidum lunatis agmina peltis
Penthesilea furens, mediisque in millibus ardet,
Aurea subnectens exsectæ cingula mammæ
Bellatrix, audetque viris concurrere virgo.*

The 20th of August we departed from Coari, with a new canow and fresh Indians; the same day, and the next day after our departure, we left on the north side of the river the two last mouths of the Yupura, and the day following we left to the south the mouths of the river at present called *Purus*, but formerly *Cuchivara*; this river is not inferior to *any* that run into the Maragnon; seven or eight leagues below the entrance of
the

the *Purus*, seeing the river without islands, and near 7200 feet wide, I tried to sound the depth, but could find no bottom at 103 fathom.

On the 23d we went up a little way the *Rio Negro*, or black river, which is a sea of fresh water that the Amazon receives on its north side. The map of father Fritz, who never went up the *Rio Negro*, and the map of America in 1722 by Mr. Delisle, copied from father Fritz, make this river run from north to south; but it is certain from the reports of all that have gone up the river, that it comes from the west and runs eastward, inclining a little to the south; I myself saw that *such* is its direction for several leagues above its mouth, by which it enters into the Amazon in so parallel a direction, that was it not for the transparency of its waters (which hath occasioned the name of *black* to be given it) one should take it for an arm of the Amazon, separated by an island. At the fort built by the Portuguese two leagues above the mouth, I measured the breadth of the *Rio Negro* in its narrowest part, and found it to be 7218 feet, and observed 3 degrees 9 minutes latitude.

The *Rio Negro* hath been frequented by the Portuguese for more than a century, and *they* carry on there a great trade of slaves; there is continually a detachment from the garrison of Para incamped on its borders, in
order

order to keep the Indians in awe, and to favour the commerce of slaves within the limits prescribed by the laws of Portugal; which do not allow the depriving any one of liberty *unless* his condition is made better by being a slave; *such* are those unhappy captives that are appointed to be killed, and to serve for food to their enemies, amongst those nations that have this barbarous custom, as we have mentioned before; for this reason the flying camp of the Black River bears the name of the *ransom troop*.

After going up the Black River for a fortnight, three weeks or more, one finds it much larger than at its mouth, on account of the great number of islands and lakes that it forms; the antient map of Mr. Delisle is in this respect more exact than the new. In all this interval the ground of the borders is high, and never subject to floods, the woods are less full of thickets, and in short the whole country hath a different face from *that* of the borders of the Amazon.

We heard at the fort of the Black River very particular accounts of the communication of *that* river with the Orinoque, and consequently of the Orinoque with the Amazon; I myself conversed with an Indian woman, whose habitation was on the borders of the Orinoque, and who had been brought from her own house in a canow to Para, all the way by water. Since my return I have received

received an account in a letter sent me from Para by the Rev. father John Ferreyra, rector of the college of Jesuits, that the Portuguese of the flying camp on the Black River, having gone up from river to river, met last year, 1744, the superior of the Jesuits of the Spanish missions on the borders of the Orinoque, with whom the Portuguese had returned by the same passage, and without landing, quite to their camp on the *Black River*, which mediates the intercourse of the Orinoque with the Amazon; this fact therefore can be no longer doubted.

The communication of the Orinoque and the Amazon, *thus* recently attested, may pass for a kind of discovery in geography; as the connexion of these two rivers, although marked without *any doubt* in antient maps, hath been universally suppressed by modern geographers in the new, and treated as chimerical.

It is in that island, the greatest of the known world, formed by the Amazon and Orinoque connected by the Black River, and which may be called the *Mesopotamia of the new world*, that there have been long sought a pretended golden lake of *Parima*, and an imaginary city of *Manoa del Dorado*; a search that hath cost the lives of so many men, and amongst the rest of Sir Walter Raleigh, a famous navigator, and one of the finest geniusses of England, whose tragical history is sufficiently known.

The

The clear crystal waters of the Black River had scarce lost their transparency, by mixing with the whitish and muddy waters of the Amazon, before we saw on the south side the first mouth of another river, that is very little inferior to the preceding, nor is it less frequented by the Portuguese: they have named it *Rio da Madeira* or river of wood; in order to give an idea of the extent of its course, it is sufficient to mention that in 1741 they went up this river as far as the neighbourhood of Santa-Cruz de la Sierra, an episcopal city of the upper Peru, situated 17 degrees and half of south latitude.

The Amazon below the mouth of the *Madeira* is commonly a league broad; it is here that the Portuguese of Para begin to give it the name of River of the Amazons. Above that they call it *Rio de Solimoes* or river of poisons, probably on account of the poisoned arrows.

On the 28th we passed the mouth of the river *Jamundas*, lying on our left; father d'Acuna names it *Cunuris*, and pretends it to be the river where Orellana was attacked by those warlike women, whom he called Amazons.

A little below on the same side we landed at the foot of the Portuguese Fort of *Pauxis*, where the bed of the river is confined within a strait about a mile broad. The tide reaches as far as this strait, at least it is perceivable

perceivable *there* by the swelling of the waters of the river, which is to be remarked every twelve hours, and is every day later as on the coast.

The utmost height of the tide, which I measured at Para, is but 10 feet and $\frac{1}{2}$ in the greatest spring-tides: but it is not to be concluded from thence that the river from Pauxis to the sea, which is a course of 200 leagues and upwards, hath no more than 10 feet and $\frac{1}{2}$ declivity; altho' such a conclusion would appear to correspond with the height of the mercury, that I observed at the Fort of Pauxis (which is 14 fathom above the level of the water) to be about 1 line $\frac{1}{4}$ less than at Para on the sea shore.

The 2d of September we departed from Pauxis; on the 5th in the evening I observed at sun-set the variation of the compass 5 degrees and half to the east. As we could find no proper place to land at, I made my observation on the trunk of a tree rooted up, which the current had driven on the edge of the river. We had the curiosity to measure it and found its length between root and branches 84 feet, and its circumference 24, altho' it was withered and stripped of its bark. By this tree which mere chance offered us, by the size of their shallops, called *pirogues*, made out of the single trunk of a tree, and by a table of a single piece 8 or 9 feet long, upon 4 and half broad, of an hard and polished wood,

wood, which we saw at the governor's house at Para, one may judge of the loftiness and beauty of the woods on the borders of the Amazon and of several rivers that join themselves to it.

I should have mentioned that on the 4th of September we began to see some mountains on the north side, at some leagues within land. It was a new sight to us, who had been navigating from the Pongo two months without seeing the least hill.

The most troublesome thing in the whole course of our navigation was the prodigious number of gnats and flies of all sorts; there are seasons and places, particularly in the country of the Omaguas, where you are continually enveloped with a thick cloud of these flying insects, whose stings cause an excessive itching.

The *greatest* known fish of fresh water is that to which the Spaniards and Portuguese have given the name of *peixe-buey* (*ox-fish*) but it must not be confounded with the *phoca* or *sea-calf*. This I am speaking of feeds on grass of the borders of the river Amazon. Its *flesh* and *fat* very much resemble *those* of veal; the female hath dugs with which she suckles her young. Father d'Acuna makes the resemblance of this fish to the ox still more complete, by attributing to it horns, which nature hath not armed it with. Properly speaking, it is not amphibious, since it

never comes intirely out of water, neither can it, having only two fins situated pretty near the head, which are flat and round in form of oars 15 or 16 feet long, and supply the place of arms and feet without having their shape. It only puts forth its head out of water, to reach the grafs along the bank. That which I drew the figure of at St. Paul d'Omaguas was a female, her length was seven feet and half, and her breadth two. I have *since* seen much larger. The eyes of this animal bear no proportion to the size of its body, they are round and have no more than three lines in diameter; the perforation of the ears is still smaller, and seems no bigger than the point of a pin. Some have thought this fish particular to the river of the Amazons, but it is not less common in the Orinoque. It is the same as was called formerly *Manati*, and is at present named *Lamentin* in the French islands of America; it is not found *at sea*, and rarely seen near the mouths of rivers, but you find it at above a thousand leagues distance from the sea in the Gual-laga, Pastaca, &c. In the Amazon it is stopped by the Pongo, above which you find it no more.

I have seen in the neighbourhood of Para a fish called *paraquè*, the body of which, like the lamprey, is full of holes, and which hath moreover the same property as the torpedo. Whoever touches it with the hand or even
with

with a stick, feels a painful numbness in the arm, and is sometimes, they say, knocked down by it; I have never seen this last fact, but instances of it are so frequent that it cannot be doubted. Mr. De Reaumur hath discovered the secret spring, by which the torpedo causes so surprising an effect; and without doubt a like mechanism produces it in the fish we are speaking of.

The turtle fish of the Amazon are in great request at Cayenne, as more delicate than any others. There are of divers sizes and different species, and in such abundance that they alone and their eggs would suffice for food to the inhabitants on the borders. There are likewise land tortoises called *jabutis* in the language of Brazile, and which are preferred at Para to the other sorts. All, but particularly the last, will live several months out of water without any perceptible food.

Nature seems to have favoured the indolence of the Indians, and to have prevented their wants; the lakes and moors that you find all along the borders of the Amazon, and sometimes very far within land, are filled with all sorts of fish at the time the river swells and over-flows its banks, and when the waters subside, they continue *there* confined as in ponds or natural reservoirs, where you may catch them with the greatest ease.

In the province of Quito, in the divers countries traversed by the Amazon, at Para,

and at Cayenne, one finds several sorts of plants, different from any known in Europe, whose leaves or roots thrown into the water have the property of making the fish drunk. The plant most commonly made use of for this purpose is called at Quito and Maynas *barbasco*. They pound it small and mix it with some bait; the fish that eats of it grows drunk, floats upon the water, and may be taken with the hand.

Crocodiles are very common in the whole course of the Amazon, and likewise in the greatest part of the rivers which the Amazon receives. I have been assured there are *some* 20 feet long. I have seen a great number from 12 to 15 and upwards on the river of Guayaquil. At the time of inundations they sometimes enter into the huts of Indians, and there are several instances of this fierce animal taking a man out of a canoe and devouring him in sight of his companions, without their being able to assist him.

The most dangerous enemy of the crocodile and perhaps the only one that dares enter the lists with him is the tiger. It must be a fine sight, and such an one as extreme good fortune alone can present, to see securely their combat; but this is what the Indians relate of it: when the tiger comes to drink on the border of the river, the crocodile puts his head out of the water to seize him, as he attacks on a like occasion oxen, horses, mules,

mules, and all that offer themselves. The tiger stamps his claws into the eyes of the crocodile, which is the only place that is penetrable on account of the hardness of his scales; the crocodile plunging immediately into the water drags the tiger after him, who suffers himself to be drowned rather than quit his hold. The Indian Maynas are very dextrous in fighting tigers with a spontoon, or half pike, which is their common instrument of defence in travelling.

I never saw any lions on the borders of the Amazon; and those which are called lions in the province of Quito, are of a different sort from the African. The male hath no mane, and is much smaller than *those* of Africa.

Bears, which are inhabitants of cold countries, and found on several mountains of Peru, I did not meet with in the woods of the Maragnon, whose climate is so different: yet I have heard them *there* mention an animal by the name of *ucumari*, which is precisely the term for a bear in the language of Peru; but I had no opportunity of being assured whether it is the same animal.

The largest native quadruped of south America is what the Spaniards of Peru call *danta*, and the Portuguese of Para *ante*; it is not so bulky as an ox, and hath no horns.

Apes are the most common game and the most pleasing to the taste of the Indians on

the borders of the Amazon. They have vast numbers and great varieties of them; some are as large as a greyhound, and others as small as a rat.

It is not surprising that in countries so hot and moist as those we are speaking of, serpents and adders of all kinds should be common. The most rare and singular of this kind is a great amphibious serpent from 25 to 30 feet long, and more than a foot in bigness, as I have been assured. I shall only mention what hath been related to me, tho' I must own it appears incredible, and I should not dare to repeat it had I not the authority of a late author in his *Orinoque illustrated*. Not only, according to the Indians, this monstrous adder swallows a roe-buck entire, but they affirm that it attracts invincibly by its breath whatever animals approach it, and devours them. Divers Portuguese of Para would have persuaded me of things almost as improbable, namely, of the manner in which a certain large adder kills a man by twisting round his body and impaling him with its tail. To judge of it by the size, it may very well be the same sort of adder as is found in the woods of Cayenne, where experience hath taught us that it is more frightful than dangerous. I knew an officer *there* that had been bitten by one of these adders in the leg without any bad consequences: perhaps, however, he was not bitten so far as to touch
8 the

the blood. I have brought home with me the skins of two of these adders, of which one, dried as it is, hath near fifteen feet in length and more than a foot in breadth; without doubt there are *some* much larger.

The number of different sorts of birds in the forests of the Amazon is greater and more various, than that of the quadrupeds: It is remarked that there is scarce any of them that have an agreeable melody; and it is chiefly on account of the splendor and diversity of colours in their plumage that they are to be admired. Nothing equals the beauty of the feathers of the *colibri*, or *bird-fly*, which lives only on the juices of flowers. Several authors have spoken of it, and it is found in America throughout the whole torrid zone. I shall only observe that altho' it is commonly reputed to inhabit the hot countries alone, yet I no where saw a greater quantity than in the gardens of Quito, whose temperate climate borders rather on cold, than excessive heat. It is named in the language of the country *quindé*. The Spaniards call it *pica-flor*.

The *toucan*, whose red and yellow bill is *monstrous* in proportion to his body, and whose tongue, which resembles a delicate feather, is accounted to have great virtues, is not peculiar to this part of the country I am speaking of.

The sorts of parrots different in size, colour, and shape, are innumerable. The Indians on the borders of the Oyapoc have the skill of procuring to parrots *artificially* natural colours, different from those which they received from nature, by drawing out feathers in different places on the neck and back, and rubbing the part plumed with the blood of certain frogs. Perhaps the *secret* consists only in wetting the part plumed with some acrid liquor, or perhaps there is no need of any such preparation; but *that* deserves trial. In reality, it doth not appear more extraordinary to see *red* or *yellow* feathers rise up in the places of *green* that have been plucked off from a bird, than to see *white* hair shoot up in the place of *black*, on the back of an horse that hath been galled.

The bird called *trompetero* by the Spaniards in the province of Maynas is the same as is named *agami* at Para and Cayenne: it hath nothing particular but the noise it makes sometimes, which hath caused the name to be given it of *trumpet* bird. Some have very improperly taken this sound for a tune or chirping; but it is evidently formed in an organ quite different, and precisely opposite to *that* of the throat.

The famous bird called at Peru *contur* and by corruption *condor*, that I have seen in several places of the mountains in the province of Quito, is found likewise, if I am rightly informed,

informed, in the low countries along the borders of the Maragnon; it is the greatest bird that wings the air, will take up commonly a lamb in its talons, even a roe buck as it is said, and hath sometimes made its prey of a child; I have seen it hovering over a flock of sheep, whilst the shepherds in consternation hooted to frighten it away, and prevent its seizing any of their flock; such as the eagle is described by Virgil, in the rape of Ganymed,

—— *Quem præpes ab Idæ*

*Sublimem pedibus rapuit Jovis Armiger
uncis:*

Longævi palmas nequicquam ad sidera tendunt

Custodes, sævitque canum latratus ad auras.

The Indians lay several sorts of snares for it; the most ingenious of all that I have heard consists in offering it for a lure, the figure of a child made of a very viscous clay, at which the *contur* stooping strikes with so rapid a force, that he fastens his talons in such manner, as makes it impossible for him to disengage himself.

The *bats*, that suck the blood of horses, mules, and even of men, when they do not secure themselves from them by sleeping under the shelter of a tent, are a common plague to the greatest part of the hot countries of America; there are *some* monstrous for their size; they have entirely destroyed at Borja, and in divers other places, the black cattle

cattle that the missionaries had introduced thither, and which began to multiply; they sting or rather bite in the night these animals, and fill themselves with blood, which continues to flow from the wound 'till it stanches of itself; these bleedings often repeated cause the animal to waste away; it is said that they make these wounds without giving any pain, at least so much as to wake a man that is asleep; many stories are related of such sort of accidents, but I knew none myself that proved fatal.

On the 19th of September, above 4 months after my departure from Cuenca; I arrived in sight of the *Para*, which the Portuguese call the *great Para*, that is to say, the *great River* in the language of Brazil.

We thought ourselves at our arrival at *Para*, after having been so long accustomed to the woods along the Amazon, transported of a sudden into Europe; we found a large city with very regular streets and agreeable houses, the greatest part of them having been rebuilt within these 30 years with stone, and magnificent churches.

The latitude of *Para* had probably never been taken at land, and I was assured at my arrival that I was precisely under the equinoctial line. The map of father Fritz places this city at 1 degree south latitude, and the new Portuguese ruttier at 1 degree 40 minutes: I found by several corresponding observations

servations 1 degree 28 minutes ; which doth not differ sensibly from the latitude in Laet's map, that hath not been followed however by any later geographer : I found the declination of the compass a little more than four degrees north-east ; it was much *greater* in the last century, and appears to be *decreasing* continually on the north coast of South America ; the little knowledge they had about a century ago of the variations of the compass, hath without doubt contributed to the errors of maps, which have given false *directions* to the mouth of the river of the Amazons, and to the coast as far as Cape de Nord.

The small-pox was very rife at that time at Para ; it is remarked that this disease is more fatal to the Indians of the mission, newly drawn out of the woods, and who go naked, than to the Indians that are cloathed, and who were born, or have a long time dwelt amongst the Portuguese : the former, a kind of amphibious animals as often in water as on land, hardened from their infancy to the injuries of the weather, have probably their skin more compact than *that* of other men ; and this circumstance alone may occasion in *them* the eruption of the small-pox to be more difficult. The custom these same Indians have of besmearing their bodies with oils and greasy substances, which must obstruct the pores, may contribute likewise to increase that difficulty ; this conjecture is confirmed
by

by another remark, *namely*, that the negro slaves transported from Africa, who have not this custom, bear this disorder better than the natives of the country; but whatever be the cause, an Indian savage, newly taken out of the woods, seized in the natural way with this disorder, is commonly reputed a dead man. How comes it to pass that it is not so in the artificial small pox? About twenty years ago a missionary Carmelite near Pará, was the first in America that had the courage to put inoculation in practice; he had already lost the half of his Indians, and many of the remaining were falling ill every day; he prudently dared therefore to inoculate the rest, having learnt the method of inoculation, and being assured of its success in Europe by reading the gazette; all those who were not yet attacked with the disorder he inoculated, and did not lose a single person; another missionary of the Black River followed his example, and with the same success.

After such authentic proofs of the virtue of inoculation, the reader will judge no doubt that in the contagion of 1743, all those who had Indian slaves would make use of a method so salutary for preserving them; yet *to the disgrace of human understanding*, it was absolutely neglected, at least it was not put in practice when I departed; perhaps the time was not yet come, they must first lose the

the half of their Indians: since my return, an account hath been received by letters from Para, that inoculation had been practised with the same success as at the first trial.

On the 29th of December I embarked at Para on board a deck-canow with twenty-two rowers for Cayenne; some leagues below Para I crossed the eastern mouth of the Amazon, or, to speak more properly, the river of Para, which is separated from the true mouth of the Amazon, by the great island known under the name of *Joannes*, and more generally at Para under the name of *Marago*; which, perhaps, is nothing but a vitious pronunciation of Maragnon.

This island occupies the whole space that separates what they commonly call the two mouths of the river; it abounds in pasturage, where they fatten a prodigious number of the large cattle, which are consumed at Para, and throughout all the colony. The island is of an irregular figure, and hath more than 150 leagues in circumference: in all maps they have substituted in its place a multitude of little islands, that one would think *placed* at hap-hazard, if they did not appear to be copied from the chart of *Flambeau de la Mer*, a book translated into all languages, which is filled in this part with details as false as they are circumstantial.

In my passage the canow struck upon a shallow, and we were obliged to wait seven days

days for a spring tide to carry her off again. Between Macapa and Cape de Nord, the spring tides come *in* of a sudden, in one or two minutes to their greatest height; I examined this phenomenon with attention, and found it to be owing to a bank of sand or high ground, that I suppose is nearly on a level with the height of the tide, which the waters having surmounted come pouring down *in mountains* with a prodigious rapidity, and sweep away every thing in their passage. I am told that the like thing happens at the Orknies to the north of Scotland, and at the mouth of the Garone near Bourdeaux.

My canow being fastened in the mud became a kind of fixed observatory; I found the variation of the compass four degrees north-east, which is nearly the same as at Para.

If you take on one side Cape de Nord, on the continent of Guiana, and on the other the point of Maguari, in the island of Marago, for the measure of the mouth of the Amazon (which in my opinion is the greatest extent that can be allowed it) I found that a straight line drawn from one of these points to the other is little less than two degrees and an half, that is to say, near fifty leagues, *allowing* twenty to a degree.

After a tedious delay on the shore, and getting off not without danger, I passed by the river and bay of *Vincent Pinçon*. The Portuguese of Para have had their reasons for
confounding

confounding this river with the river Oyapok, the mouth of which under Cape d' Orange, is at 4 degrees 15 minutes north latitude. The article of the treaty of Utrecht, that seems to make of the Oyapok, under the name of *Yacopo*, and of the river of Pinçon, one and the same river, doth not hinder them from being really fifty leagues asunder. At length after two month's navigation along the coast, which is so flat between Cape de Nord, and the island of Cayenne, that the rudder was continually striking into the mud, there not being sometimes a foot water at half a league distance from the shore; I arrived at Cayenne the 26th of February 1744.

It is well known that it was in this island Mr. Richer, a member of the academy, made in 1672, the discovery of the inequality of *gravity* under different parallels, and that *his* experiments have been one of the first foundations of the theories of Mr. Huygens, and Sir Isaac Newton, on the figure of the earth. *Vid. Newtoni principia, Prop. xx. Prob. iv.*

One of my principal motives for going to Cayenne, was the usefulness there might be in repeating the experiments of the pendulum; in which kind of operations *we* had been much exercised, and which are performed at present with greater exactness than formerly.

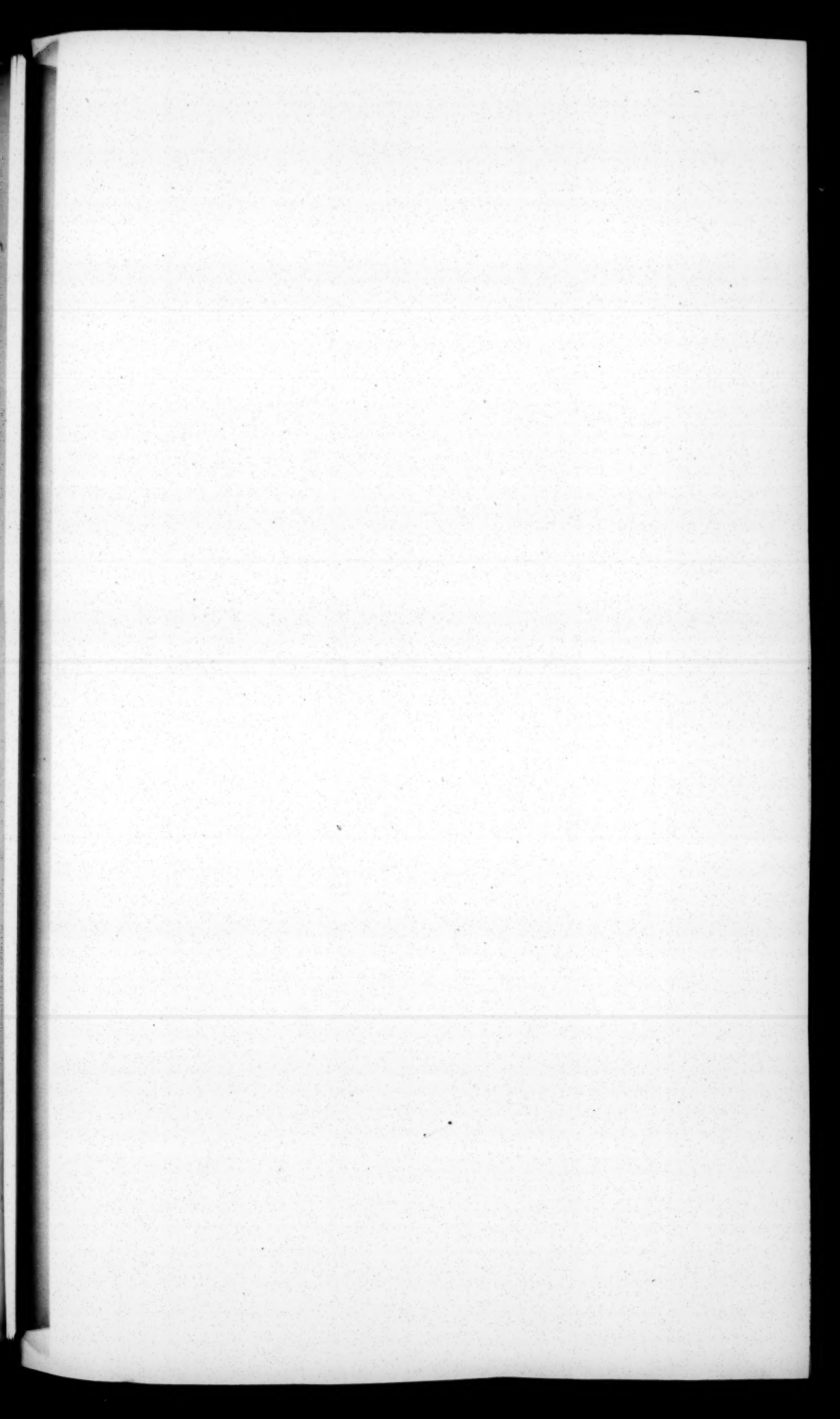
I have not yet compared the vibrations of the pendulum at Cayenne, with the number
of

of its vibrations *in an equal time* at Paris; but have deferred it for the sake of greater exactness, 'till the arrival of the individual rod of metal that I made use of at Cayenne^a. The difference of the number of oscillations of the same Pendulum in 24 hours, at Para, Quilo, and Paris, taken from a long series of experiments in each place, will give the absolute *measure* of the equinoctial pendulum on the sea-shore, *which* is the most proper of all to be by general agreement *the common measure of nations*; a thing greatly desirable in the commerce of the philosophical world!

I observed at Cayenne the same latitude as Mr. Richer, about 4 degrees 56 minutes north; but was surprised to find by four observations of the first satellite of Jupiter, which entirely corresponded together, the difference of meridians, between Cayenne and Paris, about a degree *less* than it is marked by Mr. Richer. I have since found that Mr. Richer had made no observation of the satellites of Jupiter at Cayenne, and that the longitude of the place had not been deduced in a manner agreeable to his other observations, but in a way very indirect and very liable to error.

Having remarked that from Cayenne the mountains of *Courou* could very distinctly be seen, the distance of which was reckoned
ten

^a N. B. In the year 1747. Mr. De la Condamine reported to the academy that his experiments intirely accorded with those of Mr. Richer.



[illegible]

ten leagues; I thought those mountains, from whence the fire could be perceived and the noise of the cannon from the fort of Cayenne could be heard, a proper place to measure the velocity of sound in a climate so different from Quito, *where* we had made several experiments of the same kind. By the favour and assistance of Mr. d'Orvilliers the governor of the fort, and of Mr. Fresneau the king's engineer, I made five experiments on the first and second of April, four of them agreed within half a second, upon an interval of 110 seconds of time, and I found the velocity of sound, deducting the velocity of the wind, by a geometrical measure of the distance, to be 1101 feet in a second, instead of 1050 which we had found at Quito. The velocity of the wind, which was *low*, we estimated at a *medium* between the measures taken at Cayenne and Courou; but it is possible that in the intermediate space, which was eight leagues, the velocity of the wind might have been different from our estimation. It is very difficult to remedy this inconvenience in experiments made at great distances.

Memoirs 1745, pag. 393.

It is very remarkable that all who have given experiments of the velocity of sound have differed so widely from each other, that one would think it almost impossible for philosophers

to err so much. For instance, the academy del Cimento gives it at the rate of 1185 feet in a second; Mr. Boyle at 1200; Sir Isaac Newton at 968; and Mr. Derham at 1142. Query, From whence doth this great diversity arise? May not the pendulum itself vary by the different condensation of the air, as well as by the different temperatures? For it must be supposed that experiments of this kind are made when the wind is extremely still, or at least that proper allowances are made for the wind. It seems to me very reasonable to think from analogy, that the different density of the medium in which the pendulum swings should occasion a proportionate difference in its vibrations; yet I am inclined to believe that experience doth not confirm my conjecture: and therefore I own myself at a loss to account for the great variation amongst philosophers on the velocity of sound, which is a mere experimental enquiry.

Mr. De la Condamine found that his pendulum at Para performed in 24 hours time, 31 or 32 vibrations more than at Quito, and 50 or 51 vibrations more than at Picbincha; from whence he concludes, that under the equator two bodies, the one weighing 1600 pounds, the other 1000 on a level with the sea, being conveyed, the first 8700, the second 13200 feet high, would each lose more than a pound of their weight, agreeably to the Newtonian system.

The

The reader will be pleased to observe, that in speaking of feet and fathom, I always mean the French foot and fathom; the French foot exceeds the English by seven lines and an half, or is as 107 to 114: and the French fathom, toise and brasse, must be larger in the same proportion.

We could wish for the sake of some readers that what we have to offer on this subject related rather to pigeons and turtle-doves, than to a sort of animals that one cannot see or even think of *in general* without horror. But the imagination and eyes of a philosopher are not so delicate, they are accustomed to see nature act differently from what our tastes and prejudices would prescribe to her, and frequently give a preference to animals that are the most contemptible in appearance, and the most hideous.

The occasion of the memoir that Mr. Demours, a physician, read to the company on this subject, was one of those *lucky chances* which naturalists alone can know the value of.

In the evening of one of the long days in summer, Mr. Demours being in the king's garden perceived two toads *coupled together* at the edge of an hole, which was formed in part by a great stone at the top.

Curiosity drew him to see what was the occasion of the motions he observed, when two facts equally new surprized him; the

A discovery of the male toad performing the office of a man-midwife to the female.

first was the extreme difficulty the female had in laying her eggs, infomuch that she did not seem capable of being delivered of them without some assistance. The *second* was, that the male was mounted on the back of the female, and exerted all his strength with his hinder feet in pulling out the eggs, whilst his fore-feet embraced her breast.

In order to apprehend the manner of his working in the delivery of the female, the reader must observe that the paws of these animals, as well those of the fore-feet as of the hinder, are divided into several toes, which can perform the office of fingers.

It must be remarked likewise, that the eggs of this species of toads are included each in a membranous cod that is very firm, in which is contained the embryo; and that these eggs, which are oblong and about two lines in length, being fastened one to another by a short but very strong cord form a kind of chaplet, the beads of which are distant from each other about the half of their length. It is by drawing this cord with his paw that the male performs the function of a midwife, and acquits himself in it with a dexterity that one would not expect from so lumpish an animal.

The presence of the observer did not a little discompose the male; for some time he stopped short, and threw on the *curious impertinent* a fixed look that marked his disquietness

quietness and fear; but he soon returned to his work with more precipitation than before, and a moment *after* he appeared undetermined whether he should continue it or not. The female likewise discovered her uneasiness at the sight of the stranger, by motions that interrupted sometimes the male in his operation. At length, whether the silence and steady posture of the spectator had dissipated their fear, or that the *case* was urgent, the male resumed his work with the same vigour, and successfully performed his function.

The curiosity of Mr. Demours had another object in view; he observed attentively whether the male, as he drew out the eggs, did not besprinkle them with his seminal liquor: for it is by such a sprinkling, according to the accounts of several authors, that the eggs or spawn of aquatic and amphibious animals are impregnated, and particularly the eggs of frogs as Swammerdam hath related. But as Mr. Demours did not perceive any thing like it in the two toads that were coupled, and as the place where he found them was a little darkish, he determined to put them on his hand. In consequence of which the work was again interrupted for some moments, but resumed afterwards as before. The male however did not give the least sign of what the observer had expected to discover by his eyes, or to

feel upon his hand, where he held them for a quarter of an hour.

Swammerdam hath related that the *male* of frogs assists likewise the *female* in laying her eggs; but it appears to be in a manner less continued, less perfect, and less decisive than the toad; in short, it doth not appear clearly that this aid is absolutely necessary to the frog. Perhaps it consists only in giving her a squeezing at the instant, for the female frog is delivered *immediately* of all her eggs, as the same naturalist hath observed, *uno impetu omnia ejaculatur*.

It is pity that some naturalists, who have been extremely eager of persuading us that it is to the *brutes* we owe originally our mechanical and liberal arts, as well as the more sublime sciences and particularly physick, had not been apprised of the fact we have been relating; they would without doubt have derived from thence the art of midwifery, and *the practice of men-mid-wives*.

History 1741, pag. 28.

Of insects
that multiply
without
the conjunction
of
sexes.

There are *copulations* of insects which cannot be perceived, altho' very certain, because they are performed in secret places and impenetrable to our sight: there are *others* which we are ignorant of and have not seen, for want of a method of seeing them, and the knowledge of the times and circumstances wherein they may be observed. But whatever

ever difficulty there may be in discovering the manner of the copulation of certain insects, and whatever diversity in the method of it, all modern naturalists seemed to be agreed in considering the concurrence of individuals for the propagation of each species as an indispensable condition, and as one of those general laws that nature had never been seen to infringe. If any species of animals seemed requisite to be excepted, it was *that* of hermaphrodites; but it hath been remarked even in the first years of our history, that the most acknowledged *hermaphrodite* insects, such as snails and earth worms, were not less subject to this law, under particular modifications and varieties.

Yet there is now discovered an exception to the general law, and an exception that may probably be attended with several others. Mr. De Reaumur gave some years ago the history of a kind of insect very common in the country and in our gardens, called a *vine-fretter*, which is a little viviparous animal that attaches itself to buds, flowers, and shoots of plants, oftentimes winged, and sometimes without wings. Mr. De Reaumur suspected at that time, by several marks which would have been sufficient to have *determined* an observer less skilful and less exercised in doubting, that the *vine-fretters* produced their young without having had any copulation, or any sort of commerce

with each other, or with any other insect whatever of any sensible bigness. He tried proper methods to assure himself of it; but divers accidents having caused the death of the *vine-fretters* that he kept solitary, before they arrived at the age wherein they produce their young, he wrote of it to several of his correspondents for natural history, exhorting them to repeat the experiment with all the precautions that it required. Mr. Bonnet of Geneva hath been the first to acquit himself of this delicate commission, and hath proved the fact by a thousand observations, which required no less patience than sagacity: since that Mr. De Reaumur hath been fully convinced of it himself with regard to the *vine-fretters* on poppy flowers; and he promises to give a detail of it in one of his volumes on insects. Vid. tom. vi. pag. 523.

History 1741, pag. 32.

One of the pleasures in reading natural history is to observe, that there is scarce an instance in all the wildness of fiction in the ancient fables, but nature offers something of the like kind to countenance the seeming extravagance. I have already mentioned the similitude between the fabled birth of Bacchus and the real production of soles, pag. 119. The example of the vine-fretters in like manner corresponds to that charming description in Virgil of the mares, that

that must seem absurd without the aid of philosophy ;

Ore, omnes versæ in zephyrum stant rupibus altis,

Exceptanque leves auras : et sæpe sine ullis

Conjugiis vento gravidæ (mirabile dictu)

Saxa per et scopulos et depressas convalles

Diffugiunt.

What is there in this poetic marvel, that nature doth not justify in the little insect we have been describing? One reads poetry with an additional pleasure, when it is discerned that the fables do not exceed the bounds of nature, but are, as old Hesiod expresses it,

— ἐνέμοισιν ὄμνῃα.

The deceased Mr. Raoul, a counsellor of the parliament at Bourdeaux, sent an account to Mr. De Reaumur by a letter dated in July of the last year, that there was in the priory of Tremolac of the order of Clugny, at five leagues distance from Bergerac, an inflammable and burning rivulet, which was discovered about four years ago by a fellow that went to steal craw-fish, who in order to find the holes where they conceal themselves, made use of torches of straw lighted. Whilst the man walked on the gravel of the bed of the river, almost horizontal to the water, the fire did not catch hold of the surface ; but when he got into places uneven and full of hollows, he was extremely surprised to see that

An account of an inflammable rivulet.

that the water was all in flames, insomuch that his shirt was burnt by it: it was a bluish flame. The abbot d'Alême, who was then prior of Tremolac, caused the experiment to be repeated twice or thrice, and it succeeded in the same manner. It is probable that there hath fallen, and is collected into these hollow places a mud loaded with a sulphureous matter, which is sufficiently in agitation to exhale *through* to the upper surface of the water, and *there* to catch fire at the least approach of any flame.

History 1741, pag. 36.

Here likewise, agreeably to my former observation, the phlegethon of the ancients finds its parallel, and receives new beauty from its evident conformity to nature.

Mcenia lata videt triplici circumdata muro,
Quæ rapidus flammis ambit torrentibus
 amnis

Tartareus phlegethon, torquetque sonantia
 faxa. Æneid vi.

And Silius Italicus,

——laté exundantibus urit
Ripas sævus aquis phlegethon, et turbine
 anhelo
Flammarum resonans saxosa incendia tor-
 quet. Lib. 13.

N. B. *The history of the polypus, and the new opinion concerning the origin of coral, which was espoused by several members of the academy, having been lately discussed by the Royal Society, the first in the year 1741, and the latter in the last published transactions: I shall refer the reader thither to see those subjects very curiously handled.*

It is commonly supposed that from a liquid exposed to the air, there continually rise imperceptible particles into the air, which do not fall back again upon the liquid from whence they arose, although there be not the least breath of wind to dissipate them. In order to solve this rise of vapours, it is said, that all the parts of the liquid, of water for example, as long as it continues in its liquid state, are in a continual motion; that this motion is circular or nearly so, and that on this account the imperceptible parts, which are on the surface, must rise up and fly off in a tangent. This solution seems to explain pretty well the reason why minute particles are continually detached from water that is exposed to the air.

A new theory of the evaporation of liquids.

But whence comes it that these particles after having lost the agitation, which had separated them from the mass of liquid, and darted them into the air, do not fall back again on that liquid body by their own proper

per weight? It is *this* that forms a difficulty which is extremely embarrassing; for every one knows that the parts of water, and of every other liquid, how small soever they may be, weigh bulk for bulk much more than the particles of air.

To solve this difficulty Mr. Mariotte, Dr. Halley, and several other philosophers, have proposed different hypotheses, which it would be too long to discuss in this place. Mr. Bouillet, a physician, professor of mathematics, and secretary of the academy of sciences and belles-lettres at Beziers, is content with proposing his own hypothesis, in which the main difficulty is obviated; and his solution may be considered as *new*, altho' it is only a consequence or an extension of a theory already established in the volume of our history for the year 1731, pag. 12th, *namely*,

“A liquid,” says the celebrated Mr. De Fontenelle in recording the sentiments of Mr. De Reaumur, “takes *in* air, as the tip of a
 “little piece of cloth sucks up water in
 “which it is dipped. The air being wetted
 “by the first surface of the liquid incorpo-
 “rates itself with it, hath no longer any
 “motion but what it receives from the li-
 “quid, and by *that* motion the particle of
 “air that before touched the surface is now
 “carried *elsewhere*, sinks deep within the
 “liquid, and a *new* particle of air succeeds
 “in its place at the upper surface, *which* is
 “in

“ in like manner wetted by the liquid, mixes
“ itself with it; and *thus* in a continued se-
“ ries ’till the liquid hath imbibed all the air
“ that it is capable of imbibing.”

Since water imbibes and absorbs the air that touches its surface, lodges it in its interstices, making *no longer* but one body together; carries it along by its motion of fluidity to the bottom of the vessel that contains it; and since air, notwithstanding its specific gravity, which is much less than *that* of water, unites itself with it; it follows necessarily, that air *may* take up, absorb, and imbibe water on which it floats, and against which it is continually urged by the whole weight of the atmosphere; and that water, notwithstanding its greater specific gravity, *may* insinuate itself into air, unite with it, follow all its motions, and make but an useless effort to fall back again, so long as it continues intimately mixed.

It is pretty much in the like manner that the particles of copper, silver, and of gold itself, the heaviest of all metals, keep suspended between the parts of *aqua fortis* and *aqua regia* that have dissolved them.

This theory receives great illustration from Mr. Petit’s observation on the particles of salts and metals not separating the particles of air, which we have mentioned pag. 17th and 18th.

The

The reader will observe that *as* the absorbing of air into water is a kind of *precipitation* or a *distillation per descensum*, which, in spite of the usual laws of hydrostatics, is made of a fluid less heavy into one which is more heavy; *so* the absorbing of water into air is a kind of *distillation per ascensum*, in which a liquid more heavy mounts into one that is less heavy; the method of the one is only the inversion of the method of the other.

History 1742, pag. 18.

An expli-
cation of
the pheno-
menon of
the tides
in the lake
of Gene-
va.

Mr. Addison, in his remarks on several parts of Italy, makes mention of that kind of flowing and ebbing of the lake of Geneva, that is observed *there* under the name of *seiches*, and thinks he hath discovered the true cause of it. "In summer, says he, it
" has something like an ebb and flow, which
" arises from the melting of the snows that
" fall into it more copiously at noon than at
" other times of the day."

Upon which solution Mr. Jallabert remarks, that the short continuance Mr. Addison made at Geneva did not permit him to be thoroughly informed of all the circumstances of this phenomenon; which is observed in the *morning* as well as in the *afternoon*, in *winter* as well as in the *summer*, tho' in the former season it is less frequent. He would have been told likewise that it
doth

doth not *prevail* through the whole extent of the lake, which however it ought to *do*, if it depended on the waters which the rivers swoln by the melting of snows poured thither in greater abundance.

Mr. Addison doth not explain neither why *several* ebbs and flows are observed in the same day, a circumstance that is very singular and well worthy of attention. The water swells suddenly a foot, sometimes more, and sometimes less, and sinks again very soon *after* almost as suddenly: these reciprocations of high and low water succeed one another several times in a day, in such manner however that the intervals of time between the *floods* are greater or smaller, according as the elevation of the waters is more or less considerable. Mr. Jallabert hath remarked at Geneva, upon one of the pillars which support the hydraulic machine for raising the waters of the Rhone, that when the waters of the lake rise seven or eight inches, the interval between two *floods* is about 14 or 15 minutes, and from 24 to 26 when they rise a foot.

It is not easy to assign the cause of this phenomenon; some persons have attributed it to subterraneous winds, which escaping with violence and by sudden starts, raise up the waters of the lake: but if it was owing to this cause, the swell of the water would be perceived in other places besides the extremities

tremities of the lake, it would boil up, and bubbles of air would be seen to rise from its surface, which Mr. Jallabert hath never observed.

Mr. Fatio de Duillier, a learned geometer, who was perfectly acquainted with the natural history of the country about the lake of Geneva, and hath written of it^a, attributes this kind of tides to stormy winds from the south, which blowing with violence check the waters of the lake, and hinder them from running into the Rhone with the *same* abundance, till the wind being slackened, or the water having surmounted by its weight the effort of the wind, it flows with more freedom, and in greater quantity than before: but how will this explanation tally with the *seiches* that happen in calm weather, as hath been often remarked? And how will this solve *their* appearance at the southern extremity of the lake, where the city of Geneva is situated, and from whence, in going towards the north-east, the lake is confined within a canal of about four leagues in length upon half a league, or at the most a league in breadth?

Mr. Jallabert before he proposes the explication that appears to him the most probable, premises these two remarks:

First, That towards the entrance of the Rhone that opens into the lake, the *seiches* are

^a Vid. Remarques, &c. imprimées à la fin du 2d. vol. de l'histoire de Geneve de Spon.

are observed only at Bouveret and Villeneuve, towns situated at the extremity of two little gulfs, the one to the left, the other to the right of the mouths of this river. In places more remote from this extremity of the lake, at St. Gingo for example, which is not a league distant from Bouveret, and at Vevei, which is not two leagues from Villeneuve, this phenomenon is intirely unknown. At the other extremity towards Geneva, the tides rise only in that part of the Rhone that is above the confluence of this river and the river Arve, which empties itself into the Rhone at less than a mile below Geneva, that is to say, the *seiches* appear manifest only *in that part of the lake* and for two or three miles above Geneva.

Secondly, That the *seiches* are most perceived in *close* weather threatning rain, when the air is very mild; at which times the snows melt more copiously on the mountains, experience shewing that such weather accelerates more the melting of snows than a bright sun-shine would do.

Having established these facts, Mr. Jallabert enters into the explication of the phenomenon, beginning with the *seiches* that are perceived near the entrance of the Rhone.

It is well known that this river takes its source at mount *forca*, or the *forked mountain*, which lies at the eastern extremity of the country of Valais; and that before it throws itself into the lake, it flows between

other mountains of the same country, which are always covered with snow. In mild weather the snow melts, the Rhone swells considerably, and at such times entering with impetuosity into the lake, drives the waters of it, to the right and left, into the two little gulfs that are situated near the entrance, and at the extremity of which are placed the towns of Villeneuve and Bouveret. The waters *there* at first rise on the shore of each side, and afterwards subside, in consequence of their weight *becoming* superior to the action of the waters of the Rhone against them, and resume the level of the rest of the lake. As the impetuosity of the Rhone *thus* swollen subsists for a certain time, there must result from *its* action on the *waters* of the lake, and from *their* re-action, a *flood* and an *ebb*, succeeding each other, pretty much like the alternate ascent and descent of a pendulum. The reader by casting his eyes on a map of the lake, will see that the *seiches* which are perceivable at this extremity cannot pass beyond Villeneuve and Bouveret, because the lake from those places acquires almost immediately so great a breadth that such a swell of waters diffused on so large a surface must instantly become imperceptible.

The like explication will hold for the tides that are observed at the other extremity. The river *Arve*, which takes its source in the alps of Savoy continually loaded with
2
snow,

snow, and which throws itself into the Rhone at about a mile below Geneva, cannot fail to *swell* considerably during the melting of the snows. Its waters increased, and so much the more swollen as the channel is more confined, will consequently stop *those* of the Rhone, or make them swell; and the *latter*, which compose a great part of the waters of the lake in that narrow canal which contains it above Geneva, will produce in their turn a swelling of the waters of the lake for two or three miles above that city, or at the most as far as Gentou and Bellerive, *where* experience shews us that the *seiches* of this extremity are terminated. Their ebb or sinking will be occasioned in like manner by the action of their own weight, when the waters shall have risen to a certain height, which is commonly about a foot; and this alternate action and re-action of the waters performed in an interval of 15 or 20 minutes, will produce the *floods* and *ebbs* that are the subject of our enquiry. In a word the *Arve* being swollen produces *in that part* upon the Rhone, and by means of the Rhone upon the waters contiguous to the lake, the same effect as the waters of the Rhone and *those* of the lake occasioned reciprocally the one upon the other at the entrance.

It is evident that all these effects will be so much the more considerable, as the cause producing them, according to Mr. Jallabert, shall be more distinguishable and more sud-

den; and this is what experience justifies in favour of his solution. When the melting of the snows and the fall of rains have been extraordinary, and the swell of the *Arve* reaches to or exceeds the height of the superior waters of the lake, these waters and those of the Rhone being no longer able to flow together *below* Geneva, are forced to flow back towards the city and towards the lake; and in that case *those* of the Rhone return back along the *right* superior and northern shore, and *those* of the Arve along the *left* and southern shore; the one and the other appearing *distinct* by the colour that is peculiar to them, or which they have acquired accidentally. This was observed on the 3d of December 1570, on the 21st of November 1651, on the 10th of February 1711, on the 15th of September 1733, and on the 21st of December 1740, when it was seen with surprise, that the waters of the Rhone carried away, *towards* the lake, the boats and all other bodies that were floating, and caused the mill wheels to turn in a contrary direction.

It might be alledged against the hypothesis of Mr. Jallabert, that the *seiches* have been sometimes perceived near Geneva at a time when the waters of the Arve have been *low*: but besides that these cases are very rare, and that the *seiches* then are scarcely perceivable; they never happen but when the waters of
the

the Rhone are very *low* likewise, and are always preceded by a warm wind, which dissolves the snows in a sufficient quantity to swell the Arve that was *before* extremely *low*. Of this kind Mr. Jallabert observed one in the beginning of April 1742, which rose seven or eight inches. A south-west wind, that continued 24 hours, caused the thermometer of Mr. De Reaumur to rise, from the sixth degree above 0, which answers to freezing, as high as the thirteenth. As the lake doth not begin to increase till the month of May after the melting of the snows, the Rhone is commonly very *low* in the month of April, and it was *so* in reality when the *seiches* of which we have been speaking were observed.

Mr. Addison was right *in general* in saying that this kind of ebb and flow was occasioned by the melting of the snows; but *that* amounts only to a vague conjecture, which leaves the phenomenon undetermined, and seems even opposite to it in certain respects. One makes no acquisition in physics without entering, as Mr. Jallabert hath *here* done, into an exact and rational detail of facts and circumstances.

History 1742, pag. 26.

I must do Mr. Addison the justice to observe, that though he barely mentions the melting of the snows as the cause of the ebb and flow in

the lake of Geneva, yet he is more ample in assigning the same cause for the rise of the periodical fountains in Switzerland. “ I fancied, says he, the confusion of mountains and hollows, I here observed, furnished me with a more probable reason than any I have met with for those periodical fountains, which flow only at such particular hours of the day. For as the tops of these mountains cast their shadows upon one another, they hinder the sun’s shining on several parts at such certain times, so that there are several heaps of snow which have the sun lying upon them two or three hours together, and are in the shade all the day afterwards. If therefore it happens that any particular fountain takes its rise from any of these reservoirs of snow, it will naturally begin to flow on such hours of the day as the snow begins to melt; but as soon as the sun leaves it again to freeze and harden, the fountain dries up, and receives no more supplies till about the same time the next day, when the heat of the sun again sets the snows a running, that fall into the same little conduits, traces, and canals, and by consequence break out and discover themselves always in the same place.”

Of the
spaying of
fish.

Sir Hans Sloane hath written to Mr. Geofroy an account of a man’s having been with him, to whom he was a perfect stranger, in order

order to communicate the secret he had found of spaying fish, and fattening them by that means. The man, who at first was only a net-maker, and lived about fifteen miles from Sir Hans's country-house, having acquired great skill in the breeding of fish, had gained a considerable profit from it. The singularity of the fact excited the curiosity of the learned naturalist, and the fish merchant offered to make trial of it before him. Having fetched eight *carruchens*, a kind of small carp that have been lately imported into England from Hamburg, which he had put into two large vessels filled with water, and had given fresh water twice or thrice upon the road, he dissected one of the eight carps immediately in the presence of Sir Hans, and shewed him the ovary, together with the passage which leads into the *part* that is called the cloaca. Upon another of *them* he performed the operation of spaying, by opening the ovary, and stuffing into the wound a piece of a black hat. The carp that had been spayed being put with the other six that remained, appeared to swim with somewhat less ease than the others; afterwards they were all thrown into the *basin* in Sir Hans's garden, the water of which is supplied by the neighbouring river, and *where* he believed them still living when he wrote to Mr. Geoffroy. We have not yet received any further account: the letter was sent towards the end of last De-

ember; and Samuel Tull, which is the man's name; promised Sir Hans to send him, in the following spring, some of these spayed fish, which he says exceed the others in delicacy of taste, as much as a poularde surpasses a cock, or a fat ox a bull. This effect of the spaying of fish, is very probable from its analogy with what happens to land animals: and Sir Hans thinks that such a discovery deserves to be pursued, and may be useful, both for making the fish more fat and delicate, and for diminishing their multiplying in ponds and stagnating waters, that abound too much with young fry, which prevents their growth.

History 1742, pag. 31.

Observations on Mr. Hales his account of the freezing of rivers, by the abbé Nollet.

The concurrent testimony of millers, watermen, and fishermen, confirmed by the authority of Dr. Plot in his history of Oxfordshire; determined Mr. Hales to examine into the truth of an assertion, "that rivers are found constantly to freeze first at their bottoms." In the appendix to the second volume of his statical essays, we find that he went two years successively to the Thames when it was frozen, caused the ice to be broke, and observed the river as well at the bottom as on the surface. These are his words: "The surface of the water was frozen about one-fifth of an inch thick," (*the abbé Nollet by mistake translates it one-third*) "under which ice, I saw at the bottom

“ tom another bed of ice; then breaking
 “ away some of the upper ice with a pad-
 “ dle, I took up some of the lower ice,
 “ which was about half an inch thick, but
 “ was not so solid as the surface ice, but
 “ more spongy and cavernous. This lower
 “ ice joined to the upper ice at the brink of
 “ the water, and was gradually more and
 “ more distant from it, as the bottom deep-
 “ ened; for it adhered close to the bottom,
 “ where the stones and sand were incorpo-
 “ rated into it, and which it brings up to the
 “ surface along with it.” *Pag. 356.*

Nothing can be said more positive in fa-
 vour of the vulgar opinion; it is the testi-
 mony of a skilful experimental philosopher,
 who pronounces from appearances that have
 not at all the air of equivocation: yet as de-
 cisive as they seem, if Mr. Hales judged the
 ice to be adherent to the bottom for this rea-
 son only, because it was mixed with sand and
 stones which it brought up to the surface of
 the river, it will be seen, in the course of this
 memoir, that his judgment was not so well
 founded as at first view one would be incli-
 ned to think. To dissipate, or rather to have
 prevented all doubt, I could wish that Mr.
 Hales had said positively that he had caused
 the bottom of the river to be founded in his
 presence *at some distance from the shore*, and
 that *there* he had found ice adherent in se-
 veral places. But in reading the context from
 whence

whence I have made the citation, it is manifest that the observations were made in a bay at the watering place at *Teddington*, which consequently had but little depth of water at the edges; that the ice was no more than $\frac{1}{2}$ th of an inch thick, which could not permit the observer to advance any further; and the testimony of fishermen is so often appealed to, that there is reason to fear Mr. Hales hath too easily placed his confidence in *them*. However *that* may be, I am going to relate what I have *done* and what I have *seen*, in order that the reader may perceive what may very probably have imposed on *those*, who think they have proofs of the congelation of water at the bottom of rivers.

This winter when the *Seine* was bound by the frost, the thermometer of Mr. De Reaumur being 10 degrees below the freezing point, I caused the ice to be cut three or four feet from the border, and detached from it a piece about a foot square, that was eight inches thick. When I took it I perceived that the *under* part was not smooth as it commonly is in ice that is formed from a stagnating water, neither was it compact like the rest, but very uneven, and as it were spongy, having all the appearance of a lay of ice rugged and grumous fastened *underneath* to a flake more solid and uniform; I always perceived the same thing to happen in every part of the river, where I caused pieces
of

of ice to be taken: I remarked likewise that at the bottom of the holes which I had made in the ice in order to get the pieces I have been speaking of, instead of seeing a clear water, as it commonly is when one makes a hole in the ice of a basin or a vessel, I saw nothing but little parcels of ice not well united, and intirely like *the lay* I had seen under the flake of ice I mentioned before; I caused a certain quantity of these little parcels to be taken up, but notwithstanding all the care I took to make the water clear I could never succeed in it, this sort of ice was continually renewed on the surface: and the workmen I employed, finding my design, assured me on the experience they had often had, that I took an useless labour. I was obliged to believe them with regard to the fact, but was not persuaded of the reasons they gave me for it. " This ice, said they, which we take
 " up at this hole is the ^b ragged soft part of
 " ice that is formed in the night at the bot-
 " tom of the river, and which the sun draws
 " up in the day to the surface; you may
 " observe, added they, that almost all the
 " pieces we take up, are dirty, full of earth,
 " and sometimes contain blades of grass."

Of all I heard them say, there was but one thing that appeared worthy of my attention, *namely*, the *dirtiness* of the *bouzin*, as they called it, which I found to be *real*, and attributed

^b Bouzin in French, Mr. Hales calls it the ice-meers.

tributed at first to the nearness of the shore, and to the little depth of the river in those places where I caused the ice to be opened; this notion had a probability, but soon lost it by an experiment that seemed likely to confirm it. I made *them* open the ice in places where the river was nine or ten feet deep, and when the piece of ice was lifted up I saw, contrary to my expectation, that the ragged soft part (*bouzin*) resembled very often *that* which I had observed nearer to the shore, that it contained in like manner filth, and that the surface of the water was always covered with it, whatever pains I took to remove it.

I could no longer therefore consider this *bouzin* as an ice formed near a sandy bottom, that is stirred by the agitation of the water. But must I conclude, contrary to all principles, that the ice which appears on the surface of a river, thickens only by the addition of parts frozen at the bottom? If the *freezing* of rivers is not conformable to *that* of ponds and basons, can the difference that is observed have any other cause than the motion of the water, and can that motion occasion the cold to seize the bottom before the surface? Mr. Hales in order to explain this phenomenon which he considers as certain, pretends that the bottom may acquire a sufficient degree of coldness to freeze the water, because it flows *there* more gently than elsewhere,

elsewhere, *the upper water*, says he, *being in a greater degree of motion than the lower, it cannot so soon freeze*: but I cannot yield to the supposition itself that the water freezes soonest at the bottom; for having several times, and in different years plunged thermometers to all sorts of depths in the river, when the ice of the surface was two, three, six, and even eight inches thick, I never found the water to be at the degree of cold that is necessary for freezing. Indeed it sometimes comes very near it, but even *that* is only after several days of hard freezing, and not when the ice of the surface is no more than three quarters of an inch thick; in a word, I always found that water actually fluid had never the coldness of ice; how then should it be able to transmit that coldness to the bottom over which it flows?

Altho' these experiments prevent my believing with Mr. Hales that rivers freeze at the bottom, yet it must be owned that we commonly find under the solid ice of the surface of rivers that other sort of spongy ice which I have mentioned, that it is often earthy and full of sand, and that these marks are found in it not only when it is taken up near the shore, but likewise in *places* where the river is nine or ten feet deep. We shall now endeavour to shew that these facts, tho' rightly observed, have not been explained as they ought, and that they may be reconciled with

with the usual effects of freezing and with the notions we have of it in physics.

The difficulty of exhausting the *bouzin* or *ice-meers* by the holes that had been made in the ice, induced me to think that it followed the current of the water 'till some circumstance determined it to fix beneath the solid flakes of ice; if my conjecture was right, there could be *none* but on the surface of the water, and if some obstacle was interposed to hinder it from following the stream of the current, there should no longer appear any at the place immediately below the obstacle. A large wooden shovel which I plunged perpendicularly shewed me enough to give me a good opinion of my conjecture; but as what passed by the sides did not permit me to have the surface of the water intirely clear, I sent for a cask, and having knocked out the two ends I let it down through a hole made in the ice of a suitable bigness to $\frac{3}{4}$ th of its length; by this means I formed a kind of well, from which I exhausted the ice-meers in a very little time, and was convinced that this sort of ice was carried by the current, and doth not commonly fix in the place where the freezing produced it.

To this experiment may be joined an observation I am going to mention, which alone would be sufficient in my opinion to undeceive those who think that ice arises from the bottom of the water. If it was true that it
rose

rose from thence, ought not the filth that is observed in it to be of the same kind as the bottom on which it is pretended to be formed? Yet I have observed the direct contrary, most commonly the ice-meers appeared yellow or full of sand, whilst the bottom of the river, which I caused to be sounded, was only mud for considerable distances. These ice-meers therefore must have come from some distant superior part, and if *this* be admitted, it is not difficult to explain why they should be dirty, earthy, and sometimes full of grass and straws, altho' not formed upon the ground; it is sufficient (and the supposition will easily be allowed) that they have trailed on the bottom in places where the river is low, and that the little clusters which compose them were dirtied before they united.

The reader will see by what I have been mentioning, that the vulgar opinion on the pretended formation of ice at the bottom of rivers hath some appearance of reason; but will perceive likewise that these appearances have nothing real when examined with care. It remains now to know why these deceitful appearances, these assemblages of frozen clusters, which we have named *bouzin* or ice-meers, and that cover the under part of solid flakes of ice, are found only in waters that have a current; for it is a certain fact that this sort of ice is never found in stagnating

ting waters. How *then* is it formed, and what determines it to occupy the places it usually affects?

Ice, as is well known, is water that hath lost its fluidity, or in other words, whose parts or *moleculæ* are fixed in *certain* positions relative one to another, and fastened *together* in the manner of solid bodies; the cause of this fixation is cold; but the cold operates this effect quicker or slower, according as it acts on parts that have more or less motion; for which reason pools, basons, ponds are commonly bound up before rivers, and the *latter* begin always with freezing at the edges, because the water *there* is less agitated.

The motion, which retards or hinders the effects of frost, is not the motion that the parts of water have *in common*, but rather *that* which they have each *in particular*. If the middle of the river, which is commonly called the *current*, doth not freeze as well as the edges, it is not because the water *flows* in that part, it is not *even* because it flows *there* more *swift* than elsewhere; but because it flows *by waves*^c; and that all its parts have

^c Or in the expression of Horace, which gives a more lively image,

LABORAT

Lympha fugax TREPIDARE RIVO,

where some of the commentators have absurdly interpreted the word *trepidare*, to murmur; but that sense may be confuted from Horace himself, *Epist. lib. 1. Epist. x. ver. 20.*

Purior in vicis aqua tendit rumpere plumbum,

Quam quæ per prunum trepidat cum murmure rivum?

According

have not an equal swiftness; for if it was possible that in their common motion they could keep the same respective positions to each other, I see no reason, which on such a supposition should hinder the cold from fixing them, and turning them into ice. This conclusion is not only probable but justified in all appearance by fact, for I think I am able to prove that the large pieces of ice one sees floating down a river, were formed *chiefly* of a water that hath not ceased to move, and ought not to be considered, at least for the greatest part, as fragments detached from the sides, or descending from the little rivers where care hath been taken to break the ice, as some naturalists have thought. This notion cannot support itself, if a due attention be paid to the following observations; that an *increase* of cold which renders the ice of the edges more solid, and consequently less liable to break, always *multiplies* the ice that is carried down the stream of the water, unless the frost increases to a certain degree of severity that produces a quite contrary effect; that the floating pieces of ice are *as many*, or even

According to the interpretation I have just mentioned by those learned gentlemen it follows, that the expression trepidat cum murmure is the same in signification as marmurat cum murmure; Risum teneatis? Or indeed it should rather excite a different emotion, since commentators are too generally confided in, to see such an elegant writer so miserably mangled.

To me the expression laborat trepidare conveys a very lively image of the manner in which a stream works its way with a kind of quivering motion.

even *more* numerous in the morning than in the evening; is it probable that people have been at work in breaking off the pieces of ice in the night time? Or if they come from such a distance that they may be supposed to set out the preceding day, how comes it to pass that the greatest number have not been stopped on the way either by the ice of the borders, or by a thousand other obstacles that are to be met with on a river half frozen? Moreover, if they have been detached by dint of labour, *what toil* must be supposed in order to produce so great a quantity, and how is it known that the country people *act thus* by concert, to disengage the rivers? Lastly, if *these* pieces of ice are compared never so little *with those* that are fastened to the shore, what differences may be discerned in them? The *latter* are almost always smoother, thicker, harder, and more transparent; the *former* therefore are not made of the same stuff, as I may say, but the manner of their formation I shall now explain.

If you cast your eyes on a large river, particularly in the country and in calm weather, you may observe abundance of places where the surface of the water flows in a manner *serenely smooth*, where the parts by consequence have only a velocity that is common to *all*, and are at rest respectively to each other: let us suppose such a *gliding* motion to continue some instants during a severe frost, there

there will be formed a piece of ice more or less big according to the *extent* of the *uniformity* of motion we have supposed, or *that equality* of velocity; which however we would not be understood to mean strictly *such*, but most commonly *sufficient* to give room for freezing.

If this first piece of ice, yet tender and thin, floats *some time* upon a water that continues to flow in that manner, far from breaking, it hardens more and increases in thickness, because the degree of cold it hath increasing more and more, its parts are condensed, and it becomes *itself* capable of freezing the water that *immediately* touches it; and even tho' it should pass afterwards into places where the current is *wavy*, or should knock against other ice, its hardness and dimensions may be such as to resist the *undulatory* motion and the knocks; or if it should chance to break, the pieces may still continue big enough to compose *another* by their union with *like* fragments.

But on the contrary, if *that* first ice, at the moment it begins, passes to a part of the river too much agitated (which without doubt is the most usual case) or happens to be pressed between two more solid pieces of ice, it is crushed, and reduced into very small parts that float where the waves carry them; and which most commonly do not join *together* again, or, if they join, they form only

little clusters: now these little pieces of ice formed on the whole surface of the water, but principally towards the edges, being loaded with all the particles of *foreign* matter that they at first associated, or have met with in their passage, such as *earth, mud, foam, straw*, bits of *grass*, &c. occasion *sometimes* that spunginess which is observed, and at *other times* that rough and grumous surface, which hath been thought the *print* of the soil from whence they rose.

Memoirs 1743, pag. 52.

A new
discovery
in optics.

Mr. De Buffon hath discovered that the *shadows* of bodies, which from their essence ought to be *black*, since *they* are only a privation of light, are always *coloured* at the rising and setting of the sun. I have observed, says he, in the course of this summer more than thirty rising and setting suns, all the shadows that fell upon *white*, as upon a white wall or white paper, were sometimes green, but most commonly blue, and of a blue as lively as the most beautiful azure. I have shewn this phenomenon to several persons who have been *equally* surpris'd at it. The season of the year makes no alteration. I do not know that any astronomer, natural philosopher, in a word, any one hath taken notice of this phenomenon before.

Memoirs 1743, pag. 157.

Mr.

Mr. Bouguer was willing to try what would be the effect of the heat of the sun in the torrid zone on metals, and the experiments he made discovered to him a fact that he probably would not have conjectured; *namely*, that the heat of the sun to which we can be exposed without any danger, occasions in metals an *extension* more considerable than *what* is occasioned by boiling water, altho' boiling water is capable of destroying in an instant the organisation of an animal body: the reason probably is, that the particles of fire which are mixed with the boiling water are retained *there*, and cannot insinuate themselves in a sufficient quantity into the close *pores* of iron, *that* are more adapted and proportioned to the particles of light; but the lax softness of flesh gives the particles of fire a free passage, by which they enter and dissolve the texture; whilst the solar matter, passing perhaps too easily, cannot produce that effect.

An observation of the different effects of the heat of the sun on metals and animal bodies.

History 1745, pag. 12.

I add in confirmation of the preceding remark, that it is very certain that the solar matter or particles of light are much finer and more subtil than those of fire; gold that is invincibly fixed in the most intense fires, becomes volatile in the heat of the sun by means of a burning glass, which destroys its very essence. Nothing hastens putrefaction of animal sub-

stances so much as hot vapours, perhaps because the moisture relaxes more the pores, and gives an easier admission to the particles of fire.

The conformity between electrical matter and elementary fire, by the abbé Nollet.

What is that matter which is commonly called *electrical matter*, and is with reason considered as the principal agent in the phenomena which we are solicitous to solve? from whence comes it? how is it put in action? and by what mechanism doth it produce those singular effects that we admire? These are the objects of my present inquiry.

In order to answer the *first* of these questions, I search in nature for some subtile *known* fluid, or at least *supposed* and *admitted* by the greatest number of natural philosophers, a fluid that hath *characters* resembling *those* of the matter which causes electricity, that is capable of *burning* and *giving light*, that can produce however sometimes the *one* without the *other*, that *discharges itself with a noise* according to certain circumstances, that affects our organs of *feeling* and *smelling*, if not by itself, at least by means of the substances with which it associates; for if I can find such a fluid that usually discovers itself by *such effects*, may I not with reason attribute to it *these same effects* wherever I shall meet with them?

Now *these* are the *characters* of fire properly so called, of that element which is supposed with the utmost reason to be everywhere present, not only *within* fluid mediums
and

and *round* solid bodies, but even within their inmost recesses and in the pores of their integral parts. Let us take a view of its most known properties, and compare them with *those* of the matter which makes electricity.

In the first place, the elementary fire doth not act of itself and without being excited, the bodies which contain the most of it, or which have the most disposition to yield to its action, such as oils, spirits and vapours that are called inflammable, certain torried or calcined substances, the phosphori, do not burn of themselves, or discover more heat than other bodies in the same place, unless some particular cause lets loose or excites the principle of inflammation that is within them; now of all the means proper to animate this principle, there is none more efficacious or more sudden than *that* which gives the first rise to electricity; bodies become *electrical* in the same manner as they are made *hot*; by rubbing them you produce the *one* and the *other*; they may be *electrified* by communication, as one body may *catch fire* from another that is on fire before; but in both cases it is necessary that the body, from which those qualities are originally derived, should be rubbed; thus for instance, the flame that now consumes my candle was struck at first from the flint and steel.

Secondly, when a body is rubbed in order to excite heat, the heat commonly is

D d 4

produced

produced sooner, and becomes greater in proportion as the body is denser, and its parts more elastic; all metals grow hot under the file and hammer, but iron becomes burning hot, because it hath more elasticity than the others. A cutler's grind-stone makes a blade of an *hard-tempered* steel to throw out sparks of fire every way, but if it is of a *soft* iron you see no such effect; the * Indians get fire for the common necessities of life by rubbing one against another two pieces of a sort of wood that is very hard. Whereas it is by accident only and after violent and long continued motions,

———*Metaque fervidis*
Evitata rotis,

that our common woods, which are much softer, acquire such an heat as to catch fire.

In the like manner it may be observed that bodies capable of becoming electrical by rubbing, acquire that state so much the sooner and in a more eminent degree, as their parts are stiffer and more proper for a lively reaction; white wax, for example, which becomes a little *electrical* during a hard frost, is not *so* at all when tried in warm weather or in a hot place; Spanish wax, or the gum lacca of which it is made, becomes more electrical than the former at all seasons, but

* Mr. De la Condamine mentioned that for a long tract of country along the course of the Amazon they know not what a stone is.

but is never so electrical as sulphur and amber, that may be rubbed more strongly and for a longer continuance without their parts becoming soft and losing their elasticity. Is it not on account of the reason just mentioned that glass rubbed becomes more electrical than any other substance we know of?

Thirdly, The action of fire seems to extend itself more and with greater ease in metals than in any other kind of solid bodies; if you hold by one end a rod of iron, copper, silver, &c. of a moderate length, whilst the other extremity touches the fire, the heat is soon communicated to the hand; but you do not find the same thing to happen with a rule of wood, the stem of a pipe, a block of marble or stone: I do not stop to enquire into the reason of this difference, I observe only that electricity, like heat, extends itself easily through metals, and every thing that is composed of metal; if I electrify for example a *bar of metal*, and at the same time with the same care any other body whatever, either of *the vegetable or mineral kingdom* that is not metalline, I never find so much electricity in the *latter* as in the *former*.

Fourthly, Fire that finds no obstacle, that is free from all foreign matter (it must be observed that I mean elementary fire, and that I except those cases where its rays are condensed by reflexion, refraction, or by any other way); fire, I say, that yields to the
least

least degree of motion impressed on it, is dissipated without any sensible heat, and produces nothing more than light; but if its effort is retarded and it finds opposition,

Æstuat ut clausis rapidus fornacibus ignis,

it increases more and more by *the constraint* that continues to animate it; and if it breaks thro' the confinement, like a bomb that splits, it *arms* itself, as I may say, with the parts of matter it hath divided, knocks with violence the bodies that are exposed to its shocks, and through which it would have passed quietly and without effect if it had continued in its elementary state. This principle is proved by an infinite number of very common phenomena, and it will be sufficient to cite two or three of them.

Spirit of wine with which you have wetted a finger *lights* instantly by approaching the finger to a wax-candle, but you scarce feel the flame: if the same experiment be made with some heavy oil or any greasy substance, it would kindle slower or with more difficulty, but the fire would make itself the more felt in proportion as it had more labour to break the bonds that held it; fire that sets straw in a sudden blaze hath not the same heat as if it burned new wood: of whatever kind the aliment of *fire* is, *its* activity increases according to the density or elasticity of the circumambient air, that opposes its expansion:

panfion: laftly, the fire that evaporates of itfelf from the furface of the urinary phosphorus is only light, but the internal fire that is excited by rubbing the fame phosphorus becomes prefently a real conflagration.

By adopting the fame principle with regard to electricity, I find facts that feem to juftify the application. If I electrify either by rubbing or by communication a glafs veffel exhaufted of air, and by confequence clear from vapours with which that fluid is always loaded, I perceive nothing in the infide but flafhes of light fuch as one fees in exceffive hot weather in a ferene fummer evening; but if this fame veffel continues full of air whilft it is rubbed, its electricity discovers itfelf outwardly, and the light it produces are fparkles that burn and snap: in the firft cafe the veffel being purged of air contains only an elementary fire, purified almoft from all foreign matter, this fluid at the leaft motion communicated to it *kindles* without effort and without any other effect than that of fhining in the dark; whereas in the fecond cafe the electrical emanations find a difficulty in paffing through the veffel that is full of a more refifting matter, their effort is retarded, they inflame the little portions of matter that envelop them, and *break* into glittering fparkles.

Fifthly, The matter of fire in executing the function of light moves commonly more
freely

freely in a dense body than in a rarer medium; at least this is a ^b consequence that hath been thought deducible from the laws it is observed to follow in its refractions, *namely*,
 “ that refraction out of a rarer medium into
 “ a denser, is made *towards the perpendicular*,
 “ and *from the perpendicular* when a ray passes out of a denser into a rarer medium.”

The electrical matter in like manner appears to affect to move *as long and as far* as possible in the solid body that is electrified, it issues more by the *extremities* and *saliant* angles than any where else, it is *there* it manifests itself most, as is easily seen by the luminous emanations: this law is so constant and invariable, that if the body *electrified* be a vessel full of water that *runs out*, the beginning of that efflux being then a kind of prolongation of the part, the electricity shews itself *there* in two manners very remarkable; in the first place, it makes the liquor luminous, even tho’ it is only common water; secondly, it hastens the *running* in such manner that what fell *before* drop by drop becomes a continued stream, and divides itself into several little spouts diverging from each other. Mr. Boze relates in a letter sent to Mr. De Reaumur, that the blood of a man, who had a vein opened, issued much faster whilst

^b See this consequence treated of at large in the history and memoirs for 1723, by Mr. De Mairan; and for 1744, by Mr. De Maupertuis.

whilst he was electrified; and that the drops appeared luminous like fire.

Sixthly, *Light* is transferred in an instant to great distances, whether it comes directly from its source, or is reflected or refracted: experience shews us likewise that *electricity* runs through a space of 1200 feet by means of a stretched cord in the twinkling of an eye^c.

I shall ingenuously own however that there is a considerable difference between the *propagation* of light and *that* of the electrical matter; light is propagated always in a *straight line*, whereas electricity complies with the *bendings* and *windings* of a twisted body; but I would not be understood to mean that the *motion* of the electrical matter is *modified* exactly like *that* which is peculiar to light, I think on the contrary that electricity is propagated, in some measure *like heat*, in all sorts of directions.

Seventhly, Electricity, like fire, hath never more vigour than during a frost, when the air is dry and very dense; on the contrary, during great heats, or in moist weather, it rarely happens that these sorts of experiments succeed well: moisture is injurious with regard to *the bodies* you would electrify by *friction*, but with regard to *those* you would only *communicate* electricity to, a wetted cord transmits

^c There are some very curious experiments on the instantaneous propagation of the electrical matter by the ingenious Mr. Watson in the philosophical transactions, N^o 485.

transmits extremely well that virtue, and even water as I mentioned above becomes electrical. Now *here* again I perceive a certain analogy with fire; for the *kindling* of a fire, in like manner as electricity, doth not take place in *materials* that are very wet; but if the fire hath been kindled in some other body, the heat which is the effect of it is easily communicated to *them*.

From all these properties compared I conclude therefore that it appears to me extremely probable that fire and electricity arise from the same principle; that the same matter, according to certain circumstances and agitated in a certain manner, makes us perceive heat, gives us light, and drives bodies that are not electrical towards those that are *so*.

It will be said perhaps that the *electrical matter*, if it is the same as *that of fire*, should be burning or at least hot, whereas the sparklings it forms give only a pricking sensation at the most, and when it shews itself under the form of luminous tufts, it gives no other feeling than of a slight puff that seems rather cool than hot.

But is it not well known that the ideas of *heat* and *cold* are relative to our senses? Is it not known likewise that the lightest substances and the most rarefied catch fire the most easily, that is to say, that they are *inflamed* by a degree of heat which would scarce suffice to give any sensible heat to a body that is denser?

denser? Do we not bear without any uneasiness the spirit of wine *inflamed* on the tip of a finger?

Memoirs 1745, pag. 113.

I cannot help observing as a thing extremely remarkable, that the appearance of the luminous tufts (aigrettes lumineuses as the abbé Nollet calls them) is exactly described by Virgil, whom my old master Boerhaave used commonly to stile a consummate philosopher and physician as well as a poet.

Ecce levis summo de vertice visus Iuli
Fundere lumen apex, tactuq; innoxia
molli

Lambere flamma comas, et circum tempora pasci.

Æneid. lib. ii. 682.

^d *Mr. Du Fay was the first I believe that gave substance and reality to elementary fire by applying that term to electricity: we have now a determinate idea, and our senses convey to us the notice of something that may justly enough be called elementary fire, since it resembles fire in such a number of particulars: the late Promethean art of stealing fire from the clouds, and the unhappy fate of a foreign professor, are I think a sufficient evidence of the conformity of electrical matter and elementary fire.*

^d *Vid. Memoirs 1734, pag. 520.*

I cannot conclude without mentioning with honour the glorious ardour for science that the abbé Nollet shewed in taking a journey into Italy on purpose to see the experiments of some Italian philosophers, who pretended to convey the virtues and effects of medicines by means of electricity: an account of the experiments and the disappointment he met with he sent in a letter to the late duke of Richmond, which was communicated to the Royal Society and is published in their transactions.

End of the FIRST VOLUME.



Addenda to the article of the pinna-marina,
pag. 101.

MR. Geoffroy observes that we frequently find lodged within the shells of the *pinna* little crabs (*Cicero and Pliny call them squillæ*) of which the ancients have given us very surprising accounts.

They imagined that this little animal was born *together* with the *pinna* for its preservation; for which reason they have called this animal *the guardian of the pinna*, and thought that the *pinna* perished as soon as he lost his guardian. They judged the little crab to be useful to its host in the following manner.

As the *pinna* hath no eyes and is not induced with an exquisite feeling, whilst he hath his shells *open* and the small fish enter within them, the crab gives him notice by a little bite in order to make him close on a sudden his shells; by which means the fish are caught, and the *pinna* and the crab divide the spoil between them^b.

Those that have not imagined the crab to have its birth within the shells of the *pinna*, raise our admiration of the cunning of this little animal still more, who in order to get within the *shells* takes the opportunity when *they* are open to throw in a pebble, which prevents

^b Vid. Aristotle hist. animal, lib. v. cap. xv. Cicero de naturâ deorum. lib. 2. 48. Pliny lib. ix. cap. 42. Plutarch de solert. animal. Oppian. Halieut. lib. 2. ver. 186.

A D D E N D A.

prevents their being closed and gives him admission for devouring the fish that is within.

But these notions may easily be confuted, for in the first place these little animals are found *indifferently* in all the bivalvular shell-fish, such as oysters and muscles, as well as in the *pinna*; within *whose* shells we find sometimes likewise other small shell-fish; I have a little *concha veneris* that was included, and the fish of it was alive, within the shells of a *pinna*.

Moreover the *pinna* doth not live on *flesh*, no more than muscles and oysters, but only on water and mud. Thus the pretended artifice of the little crab is useless to *him*.

Lastly, the little crabs do not *eat* the fish of the shells where they lodge; for we find these fish *whole* and *intire* together with the little crabs that accompany them.

It follows therefore that chance alone throws these little animals into the *shells*, whilst *they* are open; or that the animals retire thither in order to shelter themselves, as we frequently find them in the holes of sponges, and stones, and in the external hollows of shells.

